Governance of R&D Alliances

from a transaction cost based view

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Utrecht University
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Master Thesis Amanda Kaleveld

First Supervisor: Dr. E.M.M.I. Niesten
Copernicus Institute of Sustainable Development
Utrecht University

Second Supervisor: Dr. J. Faber
Copernicus institute of Sustainable Development
Utrecht University

Amanda Vere Kaleveld (3180794)
a.v.kaleveld@students.uu.nl
+31 61 01 97 579
Jadelaan 10,
3523 CV Utrecht
The Netherlands

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Abstract

Since the liberalization of the electric power industry in 1996, several research and development (R&D) alliances have been formed. These alliances have been formed in order to minimize the costs of new developments and to come up with more innovations. The purpose of this study is to investigate whether the misalignment of governance structure of R&D alliances influences the success of the alliance. It is hypothesized that a successful alliance minimizes the hazard of opportunism without imposing excessive bureaucracy in order to profit maximally from the cooperation. Transaction cost economics (TCE) argues that aligning the governance structure in a transaction leads to more efficient outcomes. Two types of misalignment are researched: Excessive bureaucracy hazards, and risk of opportunism. The case that is researched are the R&D collaborations on photovoltaic (PV) cells, which are currently being developed in the electric power industry in the Netherlands. It is found that misaligned governance dampens innovative performance. More specific, if transactions have an aligned governance structure then there is an overall better innovative performance of 56% compared to alliances which have a misaligned governance structure. The influence of risk of opportunism is somewhat bigger than the influence of risk of excessive bureaucracy. Transactions that suffer from the hazard of opportunism have 33,5% less innovative performance, and transactions that suffer the risk of excessive bureaucracy have 27% less innovative performance, compared to transactions that are aligned. The results provide empirical evidence for the hypothesis stated in TCE.

Key words: Transaction cost economics (TCE), (Mis)alignment, Opportunism, Hazard of bureaucracy, Photovoltaic cells (PV cells)

Contents

List of Tables and Figures

1. Introduction

1.1 Problem description

The Dutch government has since 1996 liberalized the electric power industry. The goal of liberalizing the industry is to move from a highly monopolized vertically-integrated industry with a centralized operation approach to a competitive one (Trevino, 2008). The intention of the liberalization of the electricity sector was to subdivide this sector into four segments: generation, transmission, distribution and supply. The competition was introduced in generation and supply sectors, whereas transmission and distribution remained monopolistic to guarantee the reliability of the electricity system.

In 1973 the worldwide oil crisis made us realize the necessity for conserving precious and scarce energy resources, this was the initial beginning of the governmental push for developing renewable energy. In the 1990s we saw a substantial growth of energy policy changes around the globe. These were mainly driven by economic, environmental, security, and social concerns. The energy supply was beforehand mainly based on coal, oil and natural gas for its energy. These fossil fuels are non-renewable, i.e. they draw on finite resources that will eventually diminish, become too expensive or too environmentally damaging to retrieve. Many new technologies to generate so called 'renewable energy' are being developed, in contrast these energy sources are constantly replenished and will never run out.

The most renewable energy comes either directly or indirectly from the sun. Solar energy can be used directly for heating or lighting, for generating electricity, for hot water heating, solar cooling, etc. Secondly, the heat from the sun also drives the winds, whose energy is captured in with turbines. Third, the winds and the heat from the sun causes water to evaporate, which in turn turns into rain or snow and flows downhill to rivers or streams. This energy can be captured using hydroelectric power. Fourth, sunlight causes plants to grow, this biomass can be used to produce electricity, transportation fuels or chemicals. This use of biomass is called bio-energy. However not all renewable energy sources come from the sun. Geothermal energy taps the internal heat from the earth for a variety of uses, e.g.; electric power production, and the heating and cooling of (green)houses and buildings. Another source which does not come from the sun is hydrogen. Hydrogen in high in energy, yet low in emission of greenhouse gases as CO2 and CO. In a fuel cell, hydrogen and oxygen is combined to produce electricity, heat and water. In sum the main 'renewables' are: Solar energy, wind energy, geothermal energy, bioenergy, hydrogen and fuel cells (www.renewableenergyworld.com).

Due to the unbundling of the Dutch energy sector in 1996, new entrants appeared within the generation and supply parts of the chain. Mainly due to the regulated introduction of rivalry in the electricity industries in the 1990s, the incumbent energy firms lost their monopoly position and the number of new energy firms increased (Jolink & Niesten, 2011). This dynamic environment demanded that firms reach beyond their boundaries in order to develop innovative new products, because the introduction of competition resulted in strong pressure to reduce the investment and operating costs (Trevino, 2008). This led to new interfirm collaborations, among others R&D collaborations. Interfirm R&D collaborations can be a solution for reducing the cost of these new developments (e.g. Mariti & Smiley, 1983; Powell,1990).

The use of R&D alliances is obvious and increasing during the last 20 years (e.g. Morris & Hergert, 1987; Mowery, 1988; Hagedoorn, 1993), however the performance of these alliances

has often fallen short of expectations (e.g. Bleeke & Ernst, 1993; Kogut 1989, Sampson 2004) and there is little understanding of the factors that determine the performance of an alliance (Deeds and Rothaermel, 2003).

One reason for the disappointing performance may be that occasionally collaborating partners choose a course of action that is not only self-serving, but also unfavorable to the other party. Such behavior is called opportunism (Williamson, 1985). When the stakes are high, just about everyone cheats, according to Levitt and Dubner (2005, p.24 in Hawkins et al., 2009). Opportunism can certainly decrease revenue or increase costs for the injured party (Wathne & Heide, 2000). Opportunistic behavior decreases commitment, satisfaction, cooperation and trust of the affected partner. Thus in short, opportunism damages relationships (Parkhe, 1993).

Transaction cost economics (TCE) studies how trading partners protect themselves from the hazards related with exchange relationships or opportunistic behavior. According to Williamson (1998) the core argument of TCE is the discriminating alignment hypothesis (i.e. transacting-cost-economizing alignment hypothesis). This states that transactions, which differ in their attributes, are aligned with governance structures. These governance structures differ in their cost and competence, and should therefore result in economizing transaction costs. Furthermore, Williamson (1985) states that a central tenet of TCE is that a discriminating alignment of transactions with governance leads to more efficient outcomes via reduction of transaction costs. In other words, one of the central questions by Williamson is whether and how transactions, on the one hand, and governance structures on the other hand, relate to each other.

When a governance structure is not aligned according to the discriminating alignment hypothesis and has created inefficiencies, this is called misaligned governance. Sampson (2004) examined the cost of misaligned governance in the context of R&D alliances. The author formulated the following hypothesis: “firms that choose alliance governance so as to minimize hazards of opportunism without imposing excessive bureaucracy are better positioned to realize collaborative benefits than firms that fail to do so.”(p. 485). Using a sample in the telecom equipment industry, Sampson finds that the alliance governance selected according to transaction cost arguments improves collaborative benefits substantially over governance not so selected.

Conclusively, it is known that in the telecom equipment industry alliance governance has an influence on collaborative benefits. In this research it will be investigated whether this argument also holds for PV in the electric power industry. This research will focus on R&D alliances within the electric power industry. The emphasis lies on whether the organization or governance of the alliance affected the outcomes from this R&D collaboration.

1.2 Research Question

As Williamson has argued, the issue in TCE is to set up modes of governance which efficiently match the outcomes of the transaction. Assumed is that the transactions should determine the mode of governance, rather than the modes of governance determining the transactions (Jolink and Niesten, 2008). According to Williamson (1985) transactions have two important attributes that can vary; asset specificity and behavioral uncertainty. These attributes determine the best theoretical governance structure that the transaction can have, resulting in the lowest transaction costs. Besides the theoretical best governance structure, a transaction also has an actual governance structure. If the actual and theoretical best governance structure match, then the governance structure and the transaction is aligned. But when this is not the case (i.e. the

actual and theoretical best governance structure differ) the governance structure and the transaction is misaligned. It is expected that when the governance is misaligned, results from this alliance are sub-optimal. It will be investigated whether this conclusion of Sampson (2004) also holds for the electric power industry. In other words; whether the alignment of governance with attributes of the transaction substantially improves the collaborative benefits.

In order to make the research as insightful as possible, not the whole electricity industry will be taken into account. The scope will be on solar energy, because solar power is generally accepted as a vital ingredient in the future energy supply mix (Solliance.eu), and currently develops in a rapid pace. Sustainable energy resources, like solar energy, are necessary, because in order to avoid global warming, the emission of greenhouse gases like CO_2 has to decline. Next to this, we are running out of fossil fuels. These are the main reasons we have to make a transition towards sustainable energy sources. The electric power industry can possibly make a big contribution in developing these sustainable energy sources. Photovoltaic (PV) is one of these techniques which is currently being developed. PV is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that express the photovoltaic effect. PV is a very knowledge intensive technique. Therefore, the PV sector is not a very big one, and contains approximately 52 companies in the whole chain. The companies that develop new techniques (i.e. new PV-cells, improvements in efficiency etc.) are mainly small, relatively young companies, and the wholesalers are mainly large companies with an extensive history in techniques and selling products. All these characteristics make PV as a technique appropriate for researching.

Within this research the focus will be on the cost of misaligned governance in PV R&D collaborations. The innovation transactions will be judged on the following attributes: asset specificity and behavioral uncertainty.[1] Main research question is therefore:

What is the effect of misalignment of an inter-firm governance structure on the success of a R&D collaboration on PV?

If this research can confirm that alliance governance selected according to transaction cost arguments results in better performance, then these transaction cost arguments can be used as handhelds for a successful interfirm collaboration.

In order to be able to answer the main question, several sub-questions have been formulated. The following first three questions are answered in the theoretical section: (1) What are the attributes of innovation transactions? (2) Which forms of R&D collaborations are present (in the Dutch electricity industry) on PV energy? (3) When is a transaction (mis)aligned? In the methods section, the fourth sub-question is answered: (4) When is a R&D collaboration judged as successful? In the results and conclusive section the last three sub-questions are answered: (5) Are the collaborations aligned with the attributes of innovation transactions? (6) Can the performance of R&D collaborations on PV be judged as successful? (7) Can the performance of specific collaboration be correlated to the alignment of inter-firm governance structure and transactions?

The whole PV sector will be taken into account, in other words, the sample matches the intended domain.

[1] Due to empirical underdevelopment of the attribute frequency, this attribute will not be taken into account. More about the operationalization in the methods section.

1.3 Justification

Although R&D alliances have become more important in the last 20 years, the performance of these alliances often fails to live up to the expectations and furthermore there is little understanding of the factors that determine the performance of an alliance (Bleeke & Ernst, 1993; Kogut 1989, Sampson 2004, Deeds and Rothaermel, 2003). This practical problem will be addressed, and will bring us insights in what determines the success of a R&D alliance

In theory, the primary driver is the search for efficient governance structure. Still, the theoretical framework lacks to describe the conditions leading to efficient governance of innovation (e.g. Park & Ungson, 2001; Deeds and Rothaermel, 2003). The development of the attributes of innovation transactions and the efficient governance of innovation is the theoretical contribution of this research.

Taken the above into account, it is known that in the telecom equipment industry alliance governance has an influence on collaborative benefits. In this research it will be investigated whether this argument also holds for PV in the electric power industry. Sampson's findings will be tested within another industry to see whether they still hold. When the author's findings are verified, this makes the theory more plausible or as stated in Popper's (1959: 33) words "As long as a theory withstands detailed and severe tests and is not superseded by another theory in the course of scientific progress, we may say that it has 'proved its mettle' or that it is *corroborated* by past experience.". The electric power industry differs from other industries because it has recently undergone some radical changes with respect to competition and collaboration. When this research project is successfully completed, the electric power industry will substantially benefit from the results in terms of reduction of transaction costs, due to aligned governance structures.

The PV sector in the Netherlands is still (relatively) small; therefore the whole sector will be used as the sample. The complete explanation of the case selection, choices of operationalization of dependent and independent variables as well as of the indicators chosen can be found in the methods section below.

1.4 Outline of the thesis

Chapter 2 of the article discusses the theoretical framework, starting with the concepts of behavioral assumptions, opportunism and bounded rationality. Continued the attributes of a transaction will be explained. Subsequently, governance structures and alliances will be discussed, helping to understand the concepts of (mis)alignment, innovation transaction and innovative performance which will in turn be discussed. Chapter 2 finishes with two important propositions regarding the central question posed earlier in the introduction. Chapter 3 provides the methodological framework, including operationalization of the concepts described in the theoretical section. This chapter provides some important methodological choices and the data collection and -analysis methods. Chapter 4 provides the results and evidence for the propositions stated in chapter 2. Chapter 5 discusses the limitations of this research, and propositions for additional future research are done. And chapter 6 concludes and provides an answer on the main research question.

2. Theoretical framework

The core tenet of transaction cost economics (TCE) is that economic actors match their governance structures to the attributes of transactions in a transaction cost economizing way. This argument is also known as the discriminating alignment of transaction costs. The empirical evidence shows strong support for this premise that firms choose governance consistently with transaction cost predictions (Shelanski & Klein, 1995). Recent work of Sampson (2004) examines what firms gain from best versus next best governance alternatives, in terms of transaction costs. The transaction costs are expressed in measuring the costs of misaligned governance in the context of research and development (R&D) alliances.

This article aims to address the same issue, the costs of misalignment of governance, but in contrast to Sampson's work, in a high tech sector; the photovoltaic sector.

The first section of this chapter will discuss the concepts of opportunism and behavioural uncertainty or in other words the behavioural assumptions of TCE. Section two will explain the characteristics of transactions. The third section will extensively describe what a governance structure is, and which different forms of governance can be found in transactions. In the fourth section alliances will be described, leading to the fifth section in which (mis)alignment of governance structure will be explained. Subsequently innovation transactions and their performance will respectively be discussed in section six and seven. The eighth section will present two propositions on the innovative performance and (mis)alignment of transactions.

2.1 Behavioral assumptions

As indicated by Williamson (1996), transaction cost economics is an effort to identify, explicate, and mitigate contractual hazards by aligning the governance structure. In general, all hazards can be attributed to two behavioural assumptions from which TCE works: opportunism and bounded rationality. With the introduction of these concepts Williamson departs from received neoclassical economics. Bounded rationality is defined as 'behaviour that is "*Intendedly* rational, but only *limitedly* so"' (Simon, 1961, p xxiv), and opportunism defined as 'self-interest seeking with guile'. "All complex contracts are unavoidably incomplete by reason of bounded rationality, and the convenient concept of contract as promise (unsupported by credible commitments) is vitiated by opportunism" (Williamson, 1996: 6). Opportunism and bounded rationality will respectively be defined.

Opportunism

When two companies agree upon exchanging information or knowledge, an assumption of TCE is the belief that economic actors are opportunistic. Opportunism is defined as "self-interest seeking with guile. This includes but is scarcely limited to more blatant forms, such as lying, stealing, and cheating . . . More generally, opportunism refers to the incomplete or distorted disclosure of information, especially to calculated efforts to mislead, distort, disguise, obfuscate or otherwise confuse" (Williamson, 1985: 47).

Collaborating parties take into account what information may be valuable for themselves and for their collaboration partner, and in consequence they may disguise or distort

this information. This possibility for opportunistic behaviour by the other contracting party leads the parties to devise protective governance structures (Niesten and Jolink, 2011). However, TCE does not assume that *all* human agents are opportunistic, but it is more the assumption that *some* individuals are opportunistic *some* of the time and that it is costly to identify differential trustworthiness ex ante (Williamson, 1996: 48). In other words, to avoid large costs TCE assumes that opportunism is present in a contractual relation.

Opportunism has been classified in literature in different types of opportunistic behaviour. The first is opportunism which is present before the economic partners sign a contract, in the *ex ante* stage. One of the partners might for instance lie or restrain information about the product or service that is sold. This results in information asymmetries (Nelson, 1970). Ex ante opportunism differs from ex post opportunism in the form of *moral hazard,* which refers to contracting parties that behave opportunistically during the contract implementation stage. Second, Williamson (1996) distinguishes between blatant, subtle and natural forms of opportunism. The blatant form of opportunism involves contracting parties violating a formal contract. The subtle form is strategic and has been described by Williamson as "self interest seeking with guile" (p. 225). The natural form of opportunism involves tilting the system at the margin, in which contracting parties break informal agreements. Third, opportunism can be passive or active. Passive opportunism is when contracting parties do not try their best in the relationship, like quality shirking, withholding effort etc. Active opportunism is when contracting parties deliberately behave opportunistic, like selling in unauthorized territory, deliberately misrepresent facts, etc.

In short it can be concluded that opportunism is a complex theoretical concept. The different types of opportunism show that it is possible to study opportunism from several theoretical angels. This study defines opportunism as Williamson's subtle form of opportunism: "self interest seeking with guile". The underlying reason for this defining of opportunism lies in the operationalization. A full explanation will be given in the next chapter, but the main reason for this delimitation is the way of data gathering (questionnaires), which is not appropriate to measure blatant opportunism.

Bounded rationality

The importance of bounded rationality is stressed in the work of Herbert Simon (1957, 1978). Bounded rationality is important in the study of economic organization. It is "only because individual human beings are limited in knowledge, foresight, skill, and time that organizations are useful instruments for the achievement of human purpose" (Simon, 1957). Simon defined the principle of bounded rationality as follows: "The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behaviour in the real world" (Simon, 1957: 198). An implication of bounded rationality is that people are unable to take all future situations that might occur fully into account, let alone the changes that these future situations might require in the terms of the transaction (Thompson et al, 1991). Therefore, the lesson from bounded rationality according to Williamson (1996) is that *all complex contracts are unavoidably incomplete.*

Both bounded rationality and opportunism make us refocus attention and help to distinguish between feasible and infeasible modes of governance (Williamson, 1996).

2.2 Transactions

The transaction, a transfer of a good or service, is the unit of analysis in TCE, and the means of effecting the transaction is the principal outcome of interest (Williamson, 1985). The attributes of a transaction can be roughly brought under the headings of 'asset specificity', 'uncertainty' and 'frequency'. Asset specificity as well as uncertainty matter in determining the preferred institution of governance, although the first – asset specificity – is held to be particularly important by Williamson.

Asset specificity

Asset specificity of a transaction addresses the degree to which the assets used in support of the transaction can be redeployed to 'alternative uses and by alternative users without sacrifice of productive value' (Williamson, 1991: 282). In other words, asset specificity defines the extent to which specialized or non-redeployable investments are needed to support the collaboration. If the asset specificity increases, redeployability decreases, which in turn increases bilateral dependency and contracting hazards between parties.

Asset specificity is classified in three groups: 'human assets', 'physical assets' and 'site specificity' which are respectively discussed.

Human assets

In line with the research of David and Han (2004), three measures are used to identify human asset specificity. (1) The first of three measures is 'training needs'. In a R&D collaboration it might be the case that first special skills or knowledge have to be developed, before one can fully profit from the collaboration. When it is not possible to redeploy the developed skills and/or knowledge elsewhere in the company, then the training is only useful in terms of the collaboration. In other words, when the current skills and knowledge of employees are foremost relevant in the collaboration, there is high asset specificity.

(2) A second measure used for human asset specificity is whether the information between collaboration parties is confident due to specific investments that have been done. When this is the case, both companies cannot use the knowledge or developed product/process without the partner's acceptance. Developed knowledge which is useful for the company, but which cannot be used outside the collaboration due to confidentiality is limited in its use. In other words, when information between the partners is confident, this makes the partners dependent of each other, and therefore it makes the R&D collaboration asset specific.

(3) Third and last measure for human asset specificity is whether the product or process developed in the R&D alliance is complex tot a nontrivial degree. In order to develop a complex product, more investment in terms of personnel is needed, and possibly the knowledge and skill development that is associated with the collaboration is hard, if not impossible, to relocate elsewhere in the company. Human asset specificity describes transaction specific knowledge or human capital, achieved through learning by doing. This measure might be correlated to the 'training', because training is another way to generate human capital. A complex product or process leads to more asset specificity in terms of personnel (John and Weitz, 1988).

Physical assets

Physical asset specificity refers to capital investments in customized machinery, tools, production facilities, etc. These investments can be seen as sunk costs in a collaboration when the hardware cannot be relocated elsewhere in the company. Sunk costs are costs that have been incurred and cannot be reversed. When, for example, a joint production facility has been set up, these investments make the physical assets highly specific when it is the case that these investments cannot be redeployed elsewhere in the company (Williamson, 1991).

Site specificity

Site specificity is present when both collaborating companies are in close proximity, and have a so called 'cheek-by-jowl' relation with one another. In this case it is possible to economize on inventory and exportations expenses. In some cases partners have the possibility to reflect ex ante on decisions, if this is the case the costs for coordinating activity can also be lowered (Dyer, 1996). Once the partners are sited, the assets in place are highly immobile (Joskow, 1988). Therefore, partners collaborating at close distance have an asset specific collaboration.

Uncertainty

"Transactions conducted under certainty are relatively uninteresting." According to Williamson (1979: 253), any governance structure will do when there is certainty in a transaction. More relevant are transactions where uncertainty is present to an intermediate or high degree.

Behavioral uncertainty

Behavioral uncertainty is measured with two indicators. (1) The first one is goal congruence. Goal congruence is defined as what is beneficial for one party is also in the best interests of the other party, this idea figures also prominently in agency theory (Anderson, 1985; Eisenhardt, 1989). According to Bowen and Jones (1986) "Goal incongruence arises when either party has the incentive to promote its interests at the expense of the other because the expected results from competitive behavior will exceed the returns from cooperative behavior" (p.431). In a R&D collaboration the two collaborating parties can have very different goals within the collaboration.

Take for example a notional collaboration between a university and a PV producer. In this collaboration they are testing a newly developed technique. The university would want to test their newly developed technique in the real world, and use the results of this collaboration as input for new research in which the original product will be adapted. The PV producer would want to test the technique because eventually this might lead to a next generation of PV, which would bring along benefits in terms of profits and other first mover advantages. However, the goals between the partners are incongruent; the university wants to develop the technique and the PV producer wants to eventually make money with the technique. Goal consensus should have a positive relationship with economic performance, and a negative one with uncertainty (Bourgeois, 1985).

(2) The second indicator of behavioral uncertainty is performance ambiguity. Performance ambiguity arises when any dimension of an exchange makes it difficult for the collaboration partner to evaluate the performance of the other (Bowen & Jones, 1986). The costs of negotiating, monitoring, and enforcing agreements between the partners will be higher the greater the performance ambiguity in the exchange (Anderson, 1985; Stump & Heide, 1996; Mahoney & McNally, 2004).

Asset specificity and Uncertainty

Although uncertainty is a key variable affecting strategic decisions about the firm, there are other factors that might moderate its effects. According to Williamson (1996) asset specificity is the most important and distinctive key dimensions for describing transactions: *"When asset specificity is present to a nontrivial degree, continuity between the transacting parties become necessary. In the presence of asset specificity, increases in uncertainty render market governance subject to costly haggling and maladaptiveness, and increase the relative attractiveness of hierarchies and hybrids" (Williamson 1985: p.79 (from David & Han, 2004)).*

TCE emphasizes that asset specificity will conditionally affect the vertical integration decisions (Walker and Weber, 1984). Under high asset specific conditions, uncertainty will be a more significant determinant of vertical integration because both the cost and the possibilities of hold-up from opportunistic behavior are higher. Under non-asset specific conditions, the pressure for transaction continuity would simply not exist, as there would be no assets at risk and therefore no need of protection from possible opportunism (Sutcliffe and Zaheer, 1998). Put differently, new trading relations are easily arranged, without the sacrifice of value of assets.

Frequency

According to Williamson (1985: 60) higher scores on the transaction frequency provide an incentive for firms to choose for hierarchical governance because "the cost of specialized governance structures will be easier to recover for large transactions of recurring kind." Whereas asset specificity and uncertainty have received considerable empirical examining, the variable frequency has not (Bergh and Ketchen, 2009: 224, David and Han, 2004: 52). Hence, no clear indicators have been developed to empirically test the concept of frequency.

To date, only a few TC researchers explicitly address transaction frequency. TC researchers have been largely unsuccessful in confirming the hypothesized effects of frequency, in that several studies have failed to find any positive association between transaction frequency and hierarchical governance (see e.g. Anderson, 1985; Anderson and Schmittlein, 1984; Maltz 1993, 1994; Rindfleisch and Heide, 1997). Because of the lack of empirical evidence and the earlier unsuccessful attempts in confirming the positive association of frequency and governance structure, this dimension will not be addressed in this paper. Hence, the emphasis is on asset specificity and behavioural uncertainty as important indicators influencing the governance structure. Conclusively, Uncertainty only matters in transactions which are asset specific.

2.3 Governance

In Ronald Coase's (1937) article on the nature of the firm, he conceived the firm as a governance structure, breaking with the orthodox accounts of the firm as a 'black box' production function. Coase's paper was laid aside, so to speak, for nearly four decades, until it was picked up by Williamson and other proponents of transaction cost economics in the 1970s. This work conceived the organizational form very serious, and in doing so they moved the economics of organization closer to the fields of law, organization theory, and business history (Powell, 1990).

The central governance structure to be explained is the firm. Governance structures are defined as institutional arrangements which govern the exchange by controlling opportunism. The main purpose of governance mechanisms is to provide, at a minimum of costs, the

coordination and control that is necessary for the transacting parties to believe that engaging in the exchange will make them better off (Williamson 1991, 1985).

As explained above, all complex contracts are unavoidably incomplete due to bounded rationality and opportunism (Williamson, 1988). The problem of incomplete contracting is particularly observable in R&D alliances, where valuable knowledge and technologies may be exposed. Firms may find it difficult to cooperate under such circumstances (Sampson, 2004). The alliance governance should mitigate these concerns, since the governance selected ultimately determines firm motives to cooperate. However, the structure of collaboration – or alliance governance – is often overlooked when negotiating collaborative R&D. The prescription from TCE is that firms should internalize transactions when contractual hazards are present and prefer the market when such hazards are absent.

Alliance is a very broad term, capturing various forms of inter-firm cooperation that go beyond market transactions (see e.g. Powell, 1990). Sampson (2004) focuses on two organizational alternatives; the pooling contract and the equity joint venture. There are however several other collaboration forms.

Williamson (1991) identifies three generic forms of governance: market, hybrid and hierarchy. Each form is supported by a different form of contract law, and each employs its own coordination and control system. *Market governance* matches the classical contract law, where buyers and sellers bear no responsibility toward each other and contract renewals are the result of bids meeting on the spot market. The identity of the transacting parties is irrelevant and there is no dependency between the partners. Market transactions are governed by formal terms that are presented in a legalistic way, and which is characterized by hard bargaining between parties (Williamson, 1991: 271).

In the *hybrid* form of governance, both parties preserve autonomy but are bilaterally dependent in a non-trivial way. Put differently, parties cannot be replaced costless by another partner, and therefore the identity of the parties matter. Hybrid forms are supported by neoclassical contract law, which is more elastic and adaptive than classical contract law (Williamson, 1991: 272).

A *hierarchy*, or internal organization, is yet more elastic and adaptive than hybrids. In a hierarchy, adaptation to disturbances occurs mostly through fiat. Parties within a hierarchy resolve disputes internally rather than in court, and work out differences themselves, or appeal unresolved disputes to the hierarchy for decision (David and Han, 2004).

2.4 Alliances

Markets and hierarchies are polar modes. Since the 1990s attention has progressively shifted to what Williamson identified as hybrid forms of governance. The growing literature on the hybrid mode of organization provides a clear indication of the increasing interest (Ménard, 2004). This research therefore focuses on hybrid governance, which is in turn also distinguished in three different categories. The attributes ‘contract duration’ and ‘contract flexibility’ define whether the hybrid governance is closer to a market structure, to pure hybrid governance or to a hierarchy.

Williamson (1991) is followed using ‘contract duration’ in determining which governance structure is used: When a contract runs for a longer time, the governance is closer to a hierarchy, and when a contract runs for a short time, the governance is closer to market governance. Second attribute is contract flexibility, which defines how flexible the contract is that governs the collaboration. When a contract is more flexible, the governance is closer to a

hierarchy, and when a contract is very inflexible the governance is closer to the market (Williamson, 1996).

2.5 (Mis-)Alignment

Over the last decades the TC theory has emerged as an influential paradigm in academic literature. One of the most prominent authors in this field is Nobel laureate Oliver Williamson. Drawing on his work, authors have used transaction costs to explain the configuration of organizational forms and a range of strategic phenomena, including diversification, vertical integration and joint ventures (Hill, 1990).

In figure 1, Williamson (1998) presents how he perceives the order between attributes of transactions and modes of governance. This order is based on two attributes; contractual hazards *k* and contractual safeguards *s.* This figure illustrates how transactions can be categorized and subsequently be matched to a particular mode of governance. Assume that a product can be supplied by two alternative technologies. One is a general purpose technology, the other a special purpose technology. The special purpose technology requires greater and specific investment in transaction assets.

With respect to figure 1, *k* is used as a measure of transaction-specific assets, the general purpose technology transactions are the ones for which *k = 0* (no contractual hazards). Because asset specificity does not play a role, no particular protective governance structure is needed. However, if transactions use a specific purpose technology, a *k > 0* (contractual hazards) condition exists, in this case, unassisted market contracts may not suffice due to the contractual hazards which are present. Involved parties have an incentive to insert safeguards to protect investments for transactions of the latter kind. *S* defines the magnitude of any such safeguards. *s = 0* states that no safeguards are provided in the transactions, and contrarily *s > 0* reflects that safeguards are provided.

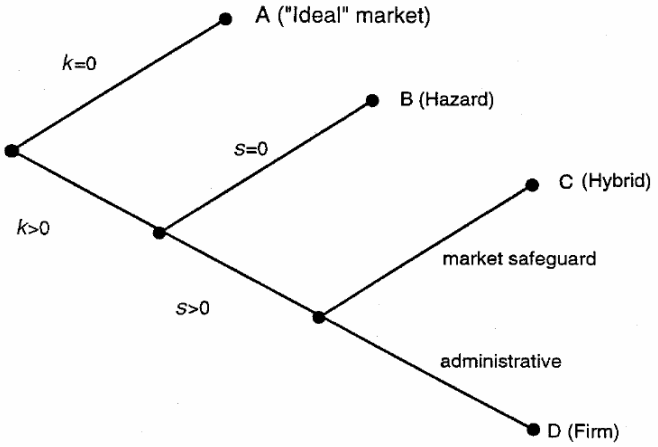

Figure 1. *Simple contracting scheme (source Williamson, 1998)*

Safeguards can take two forms. First, asset specific transactions with added contractual safeguards with the lower degree of uncertainty involved may be dealt with through interfirm contracting, or the hybrid mode of governance (node C). The second option is to take the transactions out of the market environment and organize them under unified ownership (node D). Because of the added bureaucratic costs that occur upon organizing a transaction internally,

this usually comes in only as transactions have especially high degrees of asset specificity and as added uncertainty pose greater needs for cooperative adaption.

According to Ménard (2004) "*It is the combination of opportunism, or the risk of opportunism, and of miscoordination, or the risk of miscoordination, that determines the governance characterizing hybrid organizations.".* In other words; the level of uncertainty and of asset specificity determines the governance structure in hybrid organizations. According to TCE one might align a particular set of transactions with a specific set of attributes of the modes of governance. Three stylized alignments are shown in table 1, in which a vertically integrated hierarchy, a hybrid form, and a market is represented. In this research, the hybrid mode of governance is investigated, as this is an inter-firm collaboration.

Attributes of the transaction	**Aligned modes of governance**	**Attributes of governance**
Large degrees of asset-specificity and uncertainty	Vertically integrated hierarchy	Low incentive intensity, large controls, internal dispute resolution
Intermediate degree of asset specificity and uncertainty	Hybrid	Intermediate degrees
No asset-specificity low and high uncertainty	Market	High incentive intensity, no administrative controls, court ordering

Table 1. Alignment of modes of governance with attributes of transactions.
Source: adapted from Jolink and Niesten (2008)

This research focuses on the hybrid modes of alliance, however as stated above, hybrid governance can be closer to the market, a pure hybrid, or closer to a hierarchy. Whether alliance governance is selected according to the attributes of the transaction has important implications for collaborative benefits (Williamson, 1991; Sampson, 2004; Shelanski and Klein, 1995). Misaligned governance selection forces either uncontrolled opportunism or excessive bureaucracy on the alliance.

Based on table 1, table 2 is designed. In table 2 the three hybrid modes of governance are aligned with attributes of transaction.

Attributes of the transaction	**Aligned modes of governance**
Relatively Large degrees of asset-specificity and uncertainty	Closer to a hierarchy
Intermediate degree of asset specificity and uncertainty	Pure hybrid
No asset-specificity low and relatively high uncertainty	Closer to market governance

Table 2. Alignment of modes of hybrid governance with attributes of transactions

I focus on two types of misalignment: Fist, the use of a pure hybrid governance or a governance closer to a hierarchy when a governance structure closer to the market aligns with the attributes of the transaction, in this case excessive bureaucracy is executed. And second, the use of a governance closer to a market or a pure hybrid governance when a governance closer

to a hierarchy aligns with the attributes of the transaction, in this case the risk of opportunism is relevant.

2.6 Innovation transactions

According to Schumpeter (1959) technological innovation has long been acknowledged as one of the critical driving forces in enhancing social welfare; or differently stated, innovation is seen as crucial for the long-term survival and growth of the firm. Inter-organizational collaboration has been recognized as an important support for the internal innovative activities of organizations (Deeds and Rothaermel, 2003; Dodgson 1993; Hagedoorn, 2002). Substantial investment in exploration of new technologies and processes bears the promises of increased competitiveness, whether through more efficient manufacturing processes or the introduction of new products that allow firms to charge a price premium for their goods.

The sharing of knowledge, and het development of new products (i.e. R&D) is very knowledge intensive, and information that is gathered is in most cases precious and costly to develop. Therefore, firms are tempted to organize these activities internally (e.g. Pisano, 1990).The internal organization of R&D activities reduces the feature of leakage of intellectual property to other firms, and reduces coordination difficulties. However, internal organization involves non-trivial costs that may slow down a firm's innovative progress. Collaboration helps to spread the costs of R&D among different parties (Hagedoorn, 2002; Veugelers, 1998), which results in a considerable reduction of the risks associated with R&D intensive innovation projects. Therefore, collaboration is an attractive option to keep up the innovative activities.

An innovation transaction is thus defined as a knowledge intensive collaboration, in which new products, processes or knowledge is developed. The PV sector is highly knowledge intensive, this knowledge barrier is what keeps the sector as relatively small as it is; costs are very high to join in. Therefore, it is expected that the collaborations that take place within the sector are foremost about knowledge transferring and/or knowledge development.

2.7 Innovative performance

In R&D collaborations it is mainly about the development or transferring of knowledge, or in other words: knowledge management. Several empirical works tend to assess the impact of misalignment on performance measured by accounting-based measures of profitability. This is in line with the original proposition by Williamson (1985), which refers to performance in the sense of profit, i.e. revenues minus production and transaction costs. However, economic returns on the developed knowledge are difficult to quantify and compare, therefore other indicators of success have to be used. Sampson (2004) investigates whether misaligned governance choices limit innovative benefits measured via citation-weighted firm patents. Yet, patent applications are subject to a time lag. Since my research does not include multiple years due to time and resource constraints, patents are unsuitable as an indicator for innovative performance.

The indicators used in my research follow the work of Davenport, de Long and Beers (1998): growth in the resources attached to the project, including people, money and percentage of R&D budget spent on the collaboration. I observe the alliances at only one point in time, and cannot predict whether current indicators of performance will persist.

2.8 Propositions

The basic performance proposition regarding the performance implications of transactional misalignment can be summarized as: "*the more misaligned an organizational or governance choice, the poorer the performance"* (Yvrande-Billon, 2004). Yvrande-Billon(2004: 16), who assessed many articles in the field of governance linked to performance comparisons, states: *"Generally speaking, all the reviewed articles provide results that are consistent with this (*above*) prediction since they indicate that misalignment between firms' governance decisions and degree of contractual hazards deteriorates performance ..."* .

As explained in the 'transactions' section above, a transaction has two main attributes. The first important attribute is *asset specificity*. TCE predicts that the high-powered incentives of market forms of governance hamper adaptability among transacting parties, and that market governance is ill equipped to deal with these situations of high bilateral dependency. This pushes transactions with high asset specificity into more integrated forms of governance. The involved higher bureaucratic costs are offset by the bilateral adaptive gains that are the result of the governance. To conclude; TCE predicts that transactions with low asset specificity will be undertaken in a governance closer to the market, those with intermediate asset specificity in hybrid governance forms, and those with high asset specificity in hierarchical forms of governance (David and Han, 2004; Wathne & Heide, 2000).

The second attribute of transactions is *uncertainty*. However, as explained earlier, the effect of uncertainty on the choice of governance form is conditional. When the asset specificity is low, a governance closer to the market should be preferred, regardless the degree of uncertainty. On the other hand, when asset specificity is present to a nontrivial degree, continuity between the transacting parties becomes important. In the presence of asset specificity, increases in uncertainty increase the attractiveness of governance closer to a hierarchy or to a pure hybrid governance. In sum, high uncertainty renders both market governance and hierarchies preferable to hybrids. This is summarized in table 3, coupling the different levels of asset specificity and uncertainty to the corresponding governance structure.

	Uncertainty level 1	Uncertainty level 2	Uncertainty level 3
Asset Specificity level 1	Closer to *market* governance	Closer to *market* governance	Closer to *market* governance
Asset Specificity level 2	*Pure hybrid* governance	*Pure hybrid* governance	Closer to *hierarchy* governance
Asset Specificity level 3	Closer to *hierarchy* governance	Closer to *hierarchy* governance	Closer to *hierarchy* governance

Table 3. *Level of 'asset specificity' and 'uncertainty' coupled to theoretically best governance structure*

However, the theoretically best fitting governance structure to the transactions attributes is not in all cases aligned to the actual governance structure. In table 4, the actual governance structure and the theoretically governance structure are linked and will lead to two types of misalignment; 'Risk of opportunism' (2) and 'hazard of excessive bureaucracy' (3). The aligned transactions are indicated with a (1).

Theoretically preferred governance	**Actual governance**		
	Closer to a hierarchic governance	Pure hybrid governance	Closer to market governance
Closer to hierarchic governance	(1)	Risk of opportunism (2)	Risk of opportunism (2)
Pure hybrid governance	Excessive bureaucracy (3)	(1)	Risk of opportunism (2)
Closer to market governance	Excessive bureaucracy (3)	Excessive bureaucracy (3)	(1)

Table 4. *Type of (mis)alignment*

This leads to the following propositions:

Proposition 1: The governance of R&D collaborations on PV, characterized by the risk of opportunism decreases the chance of success of the collaboration.

Proposition 2: The governance of R&D collaboration on PV, characterized by the hazard of excessive bureaucracy, decreases the chance of success of the collaboration.

3. Methods

First the research strategy will be described, leading to the operationalization of the concepts that are researched. The following sections will subsequently describe the data, data collection and data analysis.

3.1 Research Strategy

All R&D collaborations in the PV sector in the Netherlands will be investigated on three characteristics. First the attributes of the specific transaction (i.e. asset specificity and uncertainty) are mapped. Second, the governance structure which safeguards the transaction is determined, this leads to (mis)alignment of governance. And third, the success of the collaboration is measured. This is schematically shown in figure 2 below.

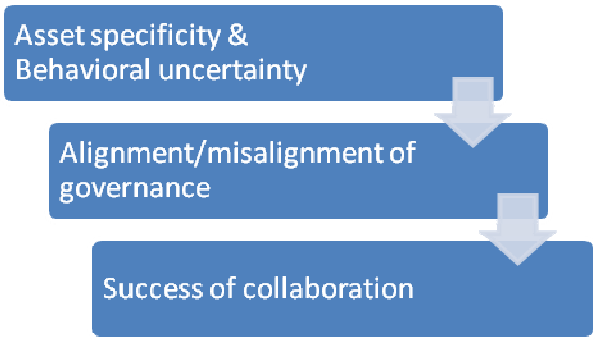

Figure 2. *Research strategy*

The PV sector in the Netherlands can be classified into five types of companies: R&D companies/institutes, Equipment and material manufacturers, Cell and module producers, PV systems producers and Wholesalers or project developers. All *current* R&D collaborations (i.e. collaborations running in 2011) between all five types of companies are researched. A complete table of all collaborations taken into account can be found in Appendix A.

A survey has been sent out to all companies in the PV industry. This will bring the most insightful results because detailed information on the properties of the R&D collaborations is necessary; a phenomena that cannot be directly observed.

Because the sector chosen is not a very large one, it has been decided that data collection is done in the whole population. In other words not just a small proportion of the population, but the whole population is researched in order to gather significant data. Information on the R&D collaborations is gathered at a single point in time. Therefore a cross-sectional survey is performed (Babbie, 1990).

3.2 Operationalization

The independent variables are operationalized according to table 5, and result in a survey which can be found in Appendix B. The indicators are measured on a five point likert scale. This scale is an ordered, one-dimensional scale from which the respondents choose one option that best

conforms to their view. The attributes of transactions, earlier described in the theory section, are discussed in turn in table 5 below.

Attribute of TCE	Measure	Indicator	Indicator source
Asset specificity	Human assets	Training needs	David and Han (2004)
		Confidentiality of information	David and Han (2004)
		Complexity of product or process	David and Han (2004), Masten (1984)
	Physical assets	Sunk costs in plant and equipment (Idiosyncratic investments)	Palay (1984)
	Site	Physical proximity (i.e. site specificity) between contracting parties	Joskow (1985;1987;1990)
Uncertainty	Behavioral	Goal congruence between parties	Olk & Young (1997), Lunnan & Haugland (2008)
		Performance ambiguity of transacting partner	Anderson, (1985); Heide and John, (1990); Stump and Heide, (1996)

Table 5. *Operationalization of the independent variables*
Source: adapted from David and Han (2004) and Macher and Richman (2008)

Asset specificity

Asset specificity refers to the extent to which specialized or non-redeployable investments are needed to support a collaboration.

Human assets
One form of asset specificity is human assets. Indicators described by David and Han (2004) are used.

The human assets are measured by four indicators. First one is the 'training needs' for personnel. On a five point likert scale companies are asked to assess whether it was necessary to train personnel specifically for this collaboration. When all skills were already in-house, this points to low asset specificity, and when large amounts of training or education of personnel was needed for the collaboration then we speak of high asset specificity.

A second indicator for human assets is the 'confidentiality of information'. This is measured by two questions; first is asked whether specifically for this collaboration investments have been done. Respondents can answer with yes or no. Subsequently, when yes was answered, it is asked whether the information between the partners is confidential due to these specific investments. Again respondents are asked to answer with yes or no. When it is not the

case that information between partners is confidential due to specific investments, we speak of low asset specificity, and vice versa of high asset specificity.

Thirdly, the 'complexity of the product' is determined. Companies are asked whether the product that is jointly being designed is complex or not. Again a five point likert scale represents the alternative answers. When there is no product design (but for example process design), the sixth answering option is 'not applicable'. When a non-complex product is designed low asset specificity is present, and when a very complex product is designed, high asset specificity exists. When 'not applicable' is answered the indicator will not be taken into account, and filled in blank.

Fourth and last measure of human assets is the 'complexity of the process'. Companies are asked to rank on a five point likert scale whether the process being jointly designed is complex or not. Again, respondents have the sixth option of answering 'not applicable' when for example only a product is designed. A non-complex process has low asset specificity, and a very complex process a high asset specificity. Again, when 'not applicable' is answered the indicator will not be taken into account, and filled in blank.

An overview of the operationalization of 'human assets' is shown in the table 6 below.

Indicator	Value options	Meaning
Training	1 = no need at all 2 = relatively little need 3 = yes, education needed 4 = yes much education needed 5 = yes very much education needed	1 = low asset specificity 2 = low asset specificity 3 = intermediate asset specificity 4 = high asset specificity 5 = high asset specificity
Confidentiality of information (due to investments)	1 = no 2 = yes	1 = low asset specificity 2 = high asset specificity
Complexity of product	1 = not complex 2 = relatively complex 3 = medium complex 4 = complex 5 = very complex 6 = not applicable	1 = low asset specificity 2 = low asset specificity 3 = intermediate asset specificity 4 = high asset specificity 5 = high asset specificity 6 = NA
Complexity of process	1 = not complex 2 = relatively complex 3 = medium complex 4 = complex 5 = very complex 6 = not applicable	1 = low asset specificity 2 = low asset specificity 3 = intermediate asset specificity 4 = high asset specificity 5 = high asset specificity 6 = NA

Table 6. Operationalization of human asset specificity

Physical asset specificity

The indicator 'physical asset specificity' is measured with two indicators. The first one is sunk costs in a joint (production) plant; a joint production plant is usually of much less value when one of the partners decides to leave the collaboration. Respondents are asked whether (joint) investments have been made in a production plant or factory especially for this collaboration. When very large investments have been done, this logically signals high asset specificity, and when no investments have been done we speak of low asset specificity.

Second indicator to 'physical assets' is 'sunk costs in equipment'. This is determined by the question whether (joint) investments have been done in equipment especially for this collaboration. When very large investments have been done, this points towards high asset specificity, and when no investments have been done there is low asset specificity.

An overview of the operationalization of 'physical assets' is shown in the table 7 below.

Indicator	Value	Meaning
Sunk costs in plant (Idiosyncratic investments)	1 = no investments done	1 = low asset specificity
	2 = small investments done	2 = low asset specificity
	3 = medium investments done	3 = intermediate asset specificity
	4 = large investments done	4 = high asset specificity
	5 = very large investments done	5 = high asset specificity
Sunk costs in equipment (Idiosyncratic investments)	1 = no investments done	1 = low asset specificity
	2 = small investments done	2 = low asset specificity
	3 = medium investments done	3 = intermediate asset specificity
	4 = large investments done	4 = high asset specificity
	5 = very large investments done	5 = high asset specificity

Table 7. Operationalization of physical asset specificity

Site specificity

Third and last indicator for asset specificity is 'site specificity'. When partners collaborate at close distance, this makes the collaboration more asset specific, because companies depend on each other being close by. Therefore respondents are asked to describe the physical distance between them and their collaboration partner. When multiple parties are taking part in the collaboration, the question should be answered for the company at the greatest distance. When one of the collaboration partners is further away, the effect of the 'cheek-by-jawl' relation is cancelled; the advantage of being close by is neutralized because not all parties are close by.

The possible answers are scaled to a five point likert scale, from less than 10 kilometers distance, to more than 120 kilometers distance. When the collaboration partner(s) are very close by, this points towards high asset specificity, and with the partner(s) very far away low asset specificity is present.

An overview of the operationalization of 'site specificity' is shown in the table 8 on the next page.

Indicator	Value	Meaning
Proximity	1 = very close by (< 10 km)	1 = high asset specificity
	2 = close by (10-40 km)	2 = high asset specificity
	3 = not close, not far away (40-80 km)	3 = intermediate asset specificity
	4 = far away (80-120 km)	4 = low asset specificity
	5 = very large distance (> 120 km)	5 = low asset specificity

Table 8. *Operationalization of site specificity*

Eventually, these seven indicators will lead to one indicator; Asset specificity. The rescaling of these seven indicators into one will be done using a factor analysis in SPSS, in order to find the correlation. SPSS will always find a factor solution to a set of variables. However, if the variables analyzed do not measure what I want (and expect) them to measure, the solution is unlikely to have any real meaning. In other words, the first thing to do is conducting a factor analysis and looking at the inter-correlation between variables. If the indicators measure the same underlying dimension (i.e. asset specificity) it is expected that they correlate with each other. If any variables are found that do not correlate with any other variables, then it will be considered to exclude these variables before the factor analysis is run. The factor analysis will lead to (ideally) one factor representing the human assets. Schematically, the factor analysis is represented in figure 3, although the intermediate variables human- physical and site specificity of the asset specificity are not calculated separately in the SPSS analysis.

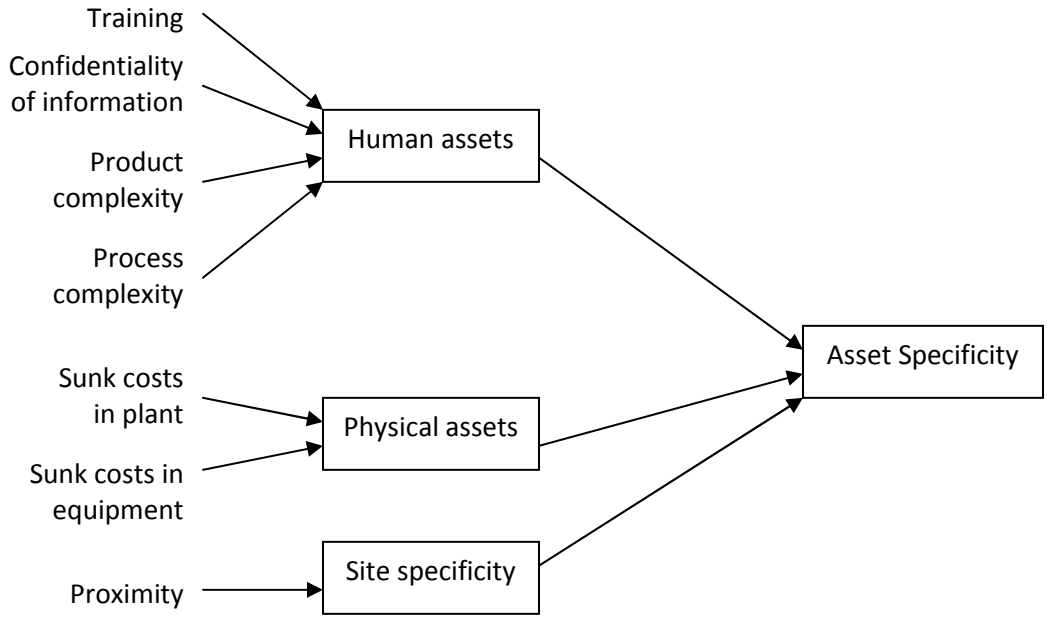

Figure 3. *Operationalization of asset specificity*

A factor analysis achieves parsimony by explaining the maximum amount of common variance in a correlation matrix using the smallest number of explanatory constructs (Field, 2009). When it is the case that the analysis leads to more than one factor for asset specificity, it has to be taken into account which variables contributes the most to the different factors. If it is unclear which variables contributes to the different factors, then another method has to be

used to find the factor for asset specificity. Presumably, the indicators that determine most of the variance of 'asset specificity', and have the largest correlation will be taken into account.

The found frequency distribution of the variable 'asset specificity' is depicted in the Appendix D, containing the SPSS output. Due to the large spread in the found data (no normal distribution can be found, whatsoever), the operationalizational choice has been made, to divide the results in three parts, comprising each approximately 33% of the data. To strengthen the validity of this method, it is made sure that the mean (3,27570) lies in the middle category, and the standard error of the mean is relatively small (0,269). In the table 9 below, the possible scores for asset specificity are assigned to three different classification levels, and the third column represents the percentage of data which is bundled in the category.

Asset specificity classification level	**Resulting score of asset specificity**	**Percentage of data in category**
1 (low)	1,098-2,196	26,7%
2 (medium)	2,197-3,843	33,3%
3 (high)	3,844-5,490	40%

Table 9. *Classification scores of asset specificity*

Uncertainty

Uncertainty refers to the behavioral uncertainty of the transacting partner, under more uncertainty, the chance of opportunistic behavior is larger (Williamson, 1979).

Behavioral uncertainty

Behavioral uncertainty is measured with two indicators. The first one is goal congruence. Goal congruence is determined with several questions. First of all, the company is directly asked to rank on a five point likert scale whether they have the same goals in the collaboration as their partner has. Because of the sensitivity of answering the questions socially correct (the goals are totally congruent, when in fact they are not), a second question is asked to check the answer of the first one. The second question asks what their goals in the collaboration are, when it is possible these goals will be checked with their collaboration partner. Checking whether the goals correspond is not possible in every case, because not all collaboration partners were willing to return the questionnaires. When the answer to the goal congruence question can not be double checked, the answer to the first goal congruence question will have to be used. When the goals are incongruent, there is high uncertainty, due to the fact that the partner could behave in an opportunistic way. When the goals are totally congruent opportunistic behavior is out of the question, and consequently uncertainty is low.

The second indicator is performance ambiguity. Performance ambiguity is defined as the difficulty faced by a company in accurately evaluating the partner's performance. The question asked to the companies is whether indicators for success were agreed upon beforehand regarding the collaboration. This can be answered with yes or no. When there has been agreed upon the indicators beforehand this indicates low behavioral uncertainty, and when this was not the case, this points towards a high uncertainty.

Both indicators are equally important to determine 'behavioral uncertainty', and have therefore the same weighing factor of 0,5. An overview of the operationalization of 'behavioral uncertainty' is shown in table 10 on the next page.

Indicator	Value	Meaning
Goal congruence between parties	1 = goals are incongruent 2 = goals are slightly incongruent 3 = goals are relatively congruent 4 = goals are congruent 5 = goals are totally congruent	1 = high uncertainty 2 = high uncertainty 3 = intermediate uncertainty 4 = low uncertainty 5 = low uncertainty
Goal congruence between parties	1 = knowledge development 2 = knowledge sharing 3 = resources sharing 4 = innovation 5 = other; ….	Check between collaboration partners
Performance ambiguity	1 = no 2 = yes	1 = high uncertainty 2 = low uncertainty

Table 10. *Operationalization of behavioral uncertainty*

In figure 4, behavioral uncertainty is operationalized schematically.

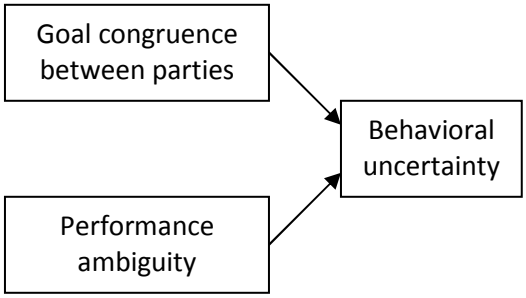

Figure 4. *Operationalization of behavioral uncertainty*

The found frequency distribution of the variable uncertainty is depicted in Appendix D, presenting the SPSS descriptive output. Due to the extremely low and insignificant correlation degree between the goal congruence and performance ambiguity, only the variable goal congruence is taken into account. Goal congruence is a measure specifically important for R&D collaboration, because in these types of collaborations goals tend to vary more than in other types of collaborations (Bowen and Jones. 1986). Furthermore, goal congruence is, in contrast with performance ambiguity, measured on a five point Likert scale. Therefore, this indicator is preferred to rescale to three categories of uncertainty. In table 11 below, the possible scores for uncertainty are assigned to three different classification levels.

Uncertainty Classification level	Resulting score of Uncertainty	Percentage of data in category
1	1,00-2,00	10%
2	2,01-3,00	36,7%
3	3,01-5,00	53,3%

Table 11. *Classification scores of uncertainty*

Governance structure

All collaborations were bound by a contract, and no equity- or joint ventures were found. However, contracts come in different degrees; they can be closer to hierarchical governance or to market governance. To find the actual type of governance structure that is in place, the duration of the contract and contract flexibility are determined.

In theory it is stated that when a contract runs for a longer time, the hybrid governance is closer to a hierarchy, and when a contract runs for a short time, the hybrid governance is closer to market governance. A second indicator for the governance structure is to determine the contract flexibility. In the questionnaire respondents are asked to rank their contract from very inflexible to very flexible on a five point Likert scale. Hybrids exist because a market is perceived as unable to adequately bundle the relevant assets, and integration into a hierarchy would reduce flexibility by creating irreversibility and weakening incentives (Teece & Pisano, 1994). In other words, collaboration partners choose a hybrid form of governance in order to maintain flexibility, but still safeguard themselves from opportunistic behavior. Within the hybrid governance different forms of flexibility are present. When a contract is more flexible, the governance is closer to a hierarchy, and when a contract is very inflexible the governance is closer to the market (Menard, 2004; Harris et al 1998).

An overview of the operationalization of the governance structure is shown in table 12 below.

Indicator	Value	Meaning
Contracted durance	…. years	From theory: low number of years = closer to market governance high number of years = closer to hierarchy governance
Contract flexibility	1 = no, very inflexible contract 2 = no, relatively inflexible contract 3 = contract is not inflexible, nor flexible 4 = yes, relatively flexible contract 4 = yes, flexible contract 5 = yes very flexible contract	1 = (closer to) market governance 2 = (closer to) market governance 3 = (closer to) pure hybrid 4 = (closer to) hierarchy governance 5 = (closer to) hierarchy governance

Table 12. *Operationalization of governance structure*

Taking both the duration of the contract and the contract flexibility equally into account, the governance structure will be determined using a factor analysis. When contradictions between both indicators arise, the concerned company will be contacted to give a decisive answer on the governance structure.

The found frequency distribution of the variable governance structure is depicted in Appendix D presenting the SPSS descriptive output. The newly created variable 'governance structure' has a distribution relatively close to a normal distribution. Therefore, the first two categories (close to market governance, and intermediate (hybrid) governance) are

approximately equal in size. Compared to the first two categories, the third is almost twice as big. This is due to the fact that the mean on the normal distribution is at the left of the centre of the graph, resulting in a somewhat askew right tale. Because the size of this tale is longer than the one on the left, the third category is bigger.

In the table 13 below, the possible scores for governance structure are assigned to three different classification levels.

Score governance analysis	Type of governance in place	Percentage of data in category
-1.704 – -0.502	Close to market governance	33,3%
-0.501 – 0.440	Pure (hybrid) governance	36,7%
0.441 – 2.400	Close to hierarchical governance	30%

Table 13. *Classification scores of governance structure*

Misalignment

The scores of asset specificity and uncertainty will be analysed, and lead to a theoretical best governance structure (i.e. a governance closer to- the market, to a pure hybrid, or to a hierarchy). When the actual governance structure, and the theoretically best governance structure are determined, it can be identified whether alignment or misalignment is the case. Table 14 below shows which degree of asset specificity and uncertainty matches which governance structure.

	Uncertainty level 1	Uncertainty level 2	Uncertainty level 3
Asset Specificity level 1	(Closer to) market governance	(Closer to) market governance	(Closer to) market governance
Asset Specificity level 2	Pure hybrid governance	Pure hybrid governance	(closer to) hierarchy governance
Asset Specificity level 3	(closer to) hierarchy governance	(closer to) hierarchy governance	(closer to) hierarchy governance

Table 14. *Transaction attributes aligned with governance structure*

When the asset specificity is low, a governance closer to the market should be preferred, whatever the degree of uncertainty. This is due to the fact that continuity matters little and new transaction arrangements can easily be arranged by both parties if necessary (Williamson, 1985). Therefore, transactions with a level one asset specificity, are theoretically best undertaken in a market governance, regardless the degree of uncertainty. On the other hand, when asset specificity is present in an intermediate form, continuity between the transacting parties becomes important, and adaptive capabilities become important. In the presence of asset specificity, increases in uncertainty increase the attractiveness of governance closer to a hierarchy. Therefore, regardless the degree of uncertainty, if the collaborations are classified as asset specificity level three then a governance structure closer to a hierarchy is theoretically the best option.

The scores for the degree of asset specificity and uncertainty will be matched to a certain type of governance structure. The comparison of the theoretically best governance and governance that is in place has several possible outcomes. Subsequently, it will be checked

whether the determined theoretical best form of governance corresponds to the actual governance in place. When the theoretical and the actual governance correspond, the transaction will be classified as aligned. And when the theoretical and actual governance does not correspond, the transaction is classified as misaligned. Either as a transactions with the 'risk of opportunism' or with the 'hazard of excessive bureaucracy'. In table 15 it can be read which type of (mis)alignment takes place. When a transaction is aligned, it is classified as a type 1 transaction, a transaction where risk of opportunism is present is classified as a type 2 transaction, and a transaction where excessive bureaucracy is at risk is classified as a type 3 transaction.

Theoretically preferred governance	**Actual governance**		
	Closer to a hierarchic governance	Pure hybrid governance	Closer to market governance
Closer to hierarchic governance	(1)	Risk of opportunism (2)	Risk of opportunism (2)
Pure hybrid governance	Excessive bureaucracy (3)	(1)	Risk of opportunism (2)
Closer to market governance	Excessive bureaucracy (3)	Excessive bureaucracy (3)	(1)

Table 15. *Type of (mis)alignment*

Innovative performance

In R&D collaborations it is mainly about the development or transferring of knowledge, or in other words: knowledge management. Economic returns on the developed knowledge are difficult to quantify and compare, therefore other indicators of success have to be used (Jobin, 2008). The indicators used follow the work of Davenport, de Long and Beers (1998): growth in the resources attached to the project, including people, money and percentage of R&D budget spent on the collaboration. An overview of the operationalization of the innovative performance is shown in table 16 below.

Indicator	Value	Meaning
Money	1 = no growth	1 = not successful (=0)
	2 = very small growth	2 = slightly successful (=1)
	3 = nor very small/nor very large growth	3 = medium successful (=2)
	4 = large growth	4 = successful (=3)
	5 = very large growth	5 = very successful (=4)
People	1 = no growth	1 = not successful (=0)
	2 = very small growth	2 = slightly successful (=1)
	3 = nor very small/nor very large growth	3 = medium successful (=2)
	4 = large growth	4 = successful (=3)
	5 = very large growth	5 = very successful (=4)
R&D budget	1 = no growth	1 = not successful (=0)
	2 = very small growth	2 = slightly successful (=1)
	3 = nor very small/nor very large growth	3 = medium successful (=2)
	4 = large growth	4 = successful (=3)
	5 = very large growth	5 = very successful (=4)
Successful?	1 = yes	1 = successful
	2 = no	2 = not successful

Table 16. *Operationalization of innovative performance*

The innovative performance results from the answers to the questions whether the money invested, people deployed, R&D budget growth and whether they would define the collaboration themselves as successful. These four indicators will be used in a factor analysis, resulting in a scale from not successful collaborations and very successful collaborations.

3.3 Data collection

In order to check whether the operationalization is relevant, two pilot interviews with specialists in the field of PV have been held. First one is with financial manager of the project Helianthos (a daughter of the utility company Nuon). Second is with a manager of the 'Brabantse Ontwikkelings Maatschappij', (BOM) who are closely involved with the PV companies in the south end of the Netherlands, and who have a very good view on the development of collaborations.

Extensive internet research has lead to a list of all companies involved in the PV sector. This list has been checked and where necessary complemented by John Blankendaal manager at the BOM. In total 52 questionnaires have been send out to the whole PV sector. The response rate of questionnaires was 58%. An overview of the participating companies can be found in appendix A. For the empirical tests I constructed a dataset based on the answers of my respondents, comprising the alliance activities and growth in resources attached to the project.

3.4 Data analysis & conceptual model

After establishing which transactions are aligned and which are misaligned, a regression analysis will be done to check whether there is a significant link between the variable 'innovative performance' and 'misalignment'. The found correlation coefficient is a measure of the relationship between two variables. For this research specific, a correlation coefficient will be

determined with Kendall's tau. Kendall's tau results in a non-parametric correlation coefficient, and can be used for a small dataset in contrast with the Spearman's correlation coefficient. The strength of the relationship between the innovative performance and misalignment is hereby determined. Subsequently, it can be tested statistically whether there is a difference in innovative performance when there is misalignment. Furthermore it will be tested whether the type of misalignment (i.e. excessive bureaucracy or when risk of opportunism) has an influence on the innovative performance of the collaboration. .

In figure 5 the conceptual model as it has been laid out in this section is represented.

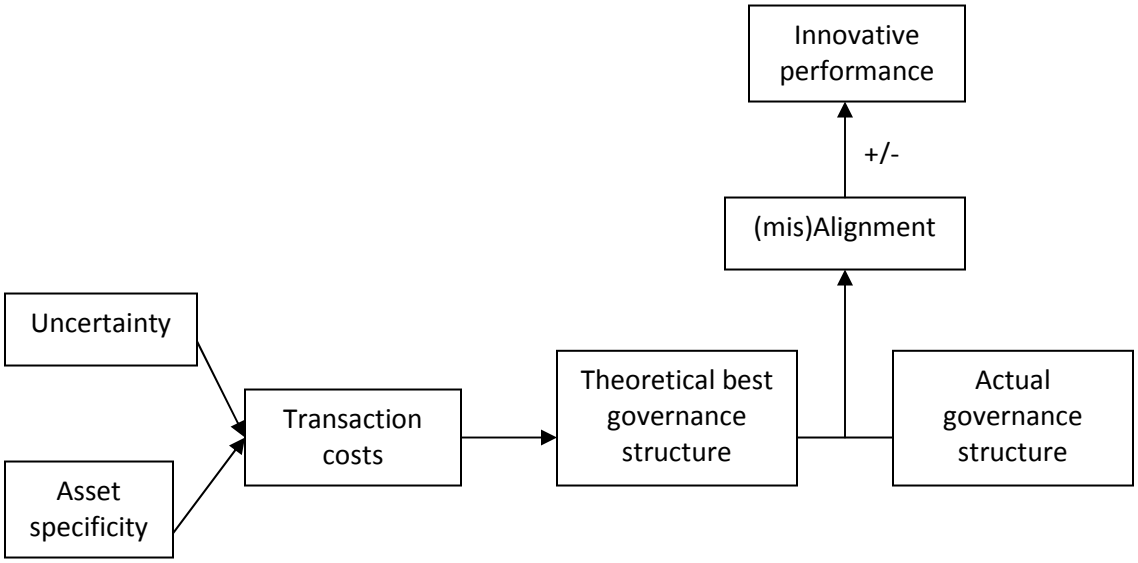

Figure 5. *Conceptual model of the research*

4. Results

In the result section, all statistical tests that are proposed in the method section are executed. First of all, the resulting transaction properties are calculated. Second, the theoretical and actual governance structures are calculated, and subsequently compared. This results in (mis)alignment of transactions and governance structures. The factor scores for innovative performance are being calculated and, as a final result, these scores will be correlated in a correlation matrix with the misalignment of transactions and governance structures.

4.1 Transaction properties

4.1.1 Asset specificity

Asset specificity is measured with three specificity indicators; 'Human assets', 'physical assets' and 'site specificity'. Initially, first these three indicators are calculated, subsequently leading to one indicator for asset specificity. As can be read from table 17 below, the Kaiser-Meyer-Olkin measure of sampling adequacy is below 0,5 for the indicator human asset specificity. Stated differently; the factor analysis that is conducted is not an adequate method in order to reduce the four variables into one, namely 'human assets'.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.385
Bartlett's Test of Sphericity	Approx. Chi-Square	15.099
	df	6
	Sig.	.019

Table 17. *KMO and Bartlett's test 'human assets'*

Therefore, it is decided that all seven variables are used in a factor analysis, in order to construct the variable 'asset pecificity', so no intermediate calculations for the variables 'human assets', 'physical assets' and 'site specificity are done. This does result, in a Kaiser-Meyer-Olkin measure of sampling adequacy of 0,511; in other words, enough to conduct a reliable factor analysis. The analysis results in just one factor, which explains 26,7% of the total variance. The Factor matrix scores can be found in table 18 below. The main conclusion which can be drawn from this matrix is that the factor is mainly influenced by product complexity and process complexity, which can be concluded from the relatively large corresponding coefficients.

Factor Matrix[a]	
	Factor
How complex is the process designed in the collaboration	.659
How complex is the product designed in the collaboration	.999
Is information between partners confidential due to specific investments	.240
Need to train personnel specific for this collaboration	-.102
Are investments done in a plant specifically for this collaboration	.128
Are investments done in equipment specifically for this collaboration	.228
Physical proximity between partners	-.305

Extraction Method: Maximum Likelihood.

a. 1 factor extracted. 7 iterations required.

Table 18. *Factor matrix 'asset specificity'*

Given that mainly the process- and product complexity influence the asset specificity, a new analysis is run in order to identify the asset specificity of the transactions. In this third analysis only these two variables are taken into account. Resulting in one factor, explaining 83% of the variance, and both variables have a significant coefficient of 0,549. This leads us to a classification of asset specificity depicted in table 19 (Which is a copy of table 9 in the methods section)**.**

Asset specificity classification level	**Resulting score of asset specificity**	**Percentage of data in category**
1 (low)	1,098-2,196	26,7%
2 (medium)	2,197-3,843	33,3%
3 (high)	3,844-5,490	40%

Table 19. *Classification scores of asset specificity*

4.1.2 Uncertainty

The variable 'uncertainty' is constructed with the variables 'goal congruence' and 'performance ambiguity'. Initially, the answer on goal congruence was checked between the collaboration partners, by asking both what their goals in the collaboration are. However, as not all collaboration partners have returned the questionnaire, and as some collaboration partners were confinential, it was not possible to check the goal congruence between partners. Only in 10% of the collaborations this was possible, in these instances goals turned out to be congruent. On the variables 'goal congruence 'and 'performance ambiguity' a factor analysis is conducted to construct one coefficient. However, th analysis of these two indicators results in two extremely insignificant factors. As can be seen in table 20, both factors explain precisely 50% of the variance. Stated differently, both factors represent one of the indicators. Therefore, the methodological decision has been made to take only the indicator goal congruence into account, as this indicator is measured on a five point likert scale and thus givers more differentiated answers than the factor performance ambiguity (which in measured binairy).

Total variance explained

Component	Initial eigenvalues		
	Total	% of variance	Cumulative %
Factor 1. (*goal congruence*)	1.000	50.000	50.000
Factor 2. *(performance ambiguity*)	1.000	50.000	100.000

Extraction Method: Principal Component Analysis.

Table 20. *Total variance explained 'uncertainty'*

In table 21 (which is a copy of table 11) the classification of uncertainty is depicted.

Uncertainty Classification level	**Resulting score of Uncertainty**	**Percentage of data in category**
1	1,00-2,00	10%
2	2,01-3,00	36,7%
3	3,01-5,00	53,3%

Table 21. *Classification scores of uncertainty*

4.2 Governance structure

4.2.1 Theoretical governance structure

The theoretical best governance structure results from the attributes of transaction costs: 'asset specificity' and 'uncertainty'. Table 22 is a copy of table 14 found in the methods section, and this table again shows which attributes matches which governance structure theoretically.

	Uncertainty level 1	**Uncertainty level 2**	**Uncertainty level 3**
Asset Specificity level 1	(Closer to) market governance	(Closer to) market governance	(Closer to) market governance
Asset Specificity level 2	Pure hybrid governance	Pure hybrid governance	(closer to) hierarchy governance
Asset Specificity level 3	(closer to) hierarchy governance	(closer to) hierarchy governance	(closer to) hierarchy governance

Table 22. *Transaction attributes aligned with governance structure*

The bar chart of figure 6 is the result of the analysis.

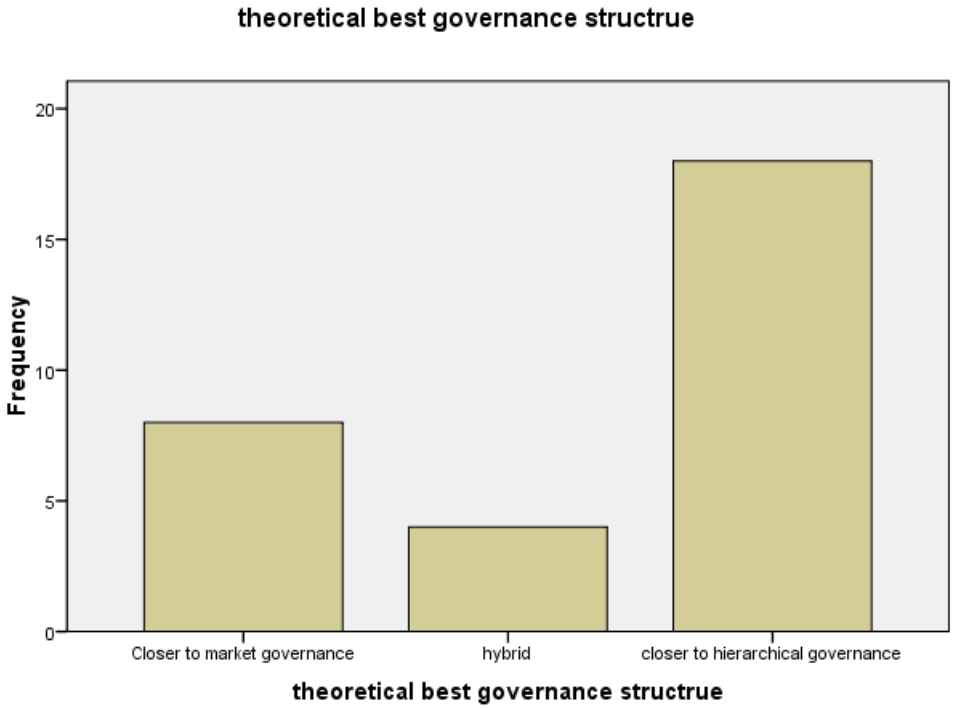

Figure 6. *Theoretical best governance structure*

4.2.2 Actual governance structure

The governance structure is determined with the use of the variables 'contract duration' and 'contract flexibility'. The factor analysis of these two variables results in one significant factor, explaining 65,8% of the variance (see table 23).

Total Variance Explained

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	1.315	65.759	65.759	1.315	65.759	65.759
2	.685	34.241	100.000			

Extraction Method: Principal Component Analysis.

Table 23. *Variance explained in factor 'governance structure'*

The distribution of governance structure is close to a normal distribution. The first two categories (close to market governance, and pure (hybrid) governance) are approximately equal in size. Compared to the first two categories, the third is almost twice as big. This is due to the fact that the mean on the normal distribution is at the left of the centre of the graph, resulting in a somewhat skewed right tale. Because the size of this tale is longer than the one on the left, the third category is bigger.

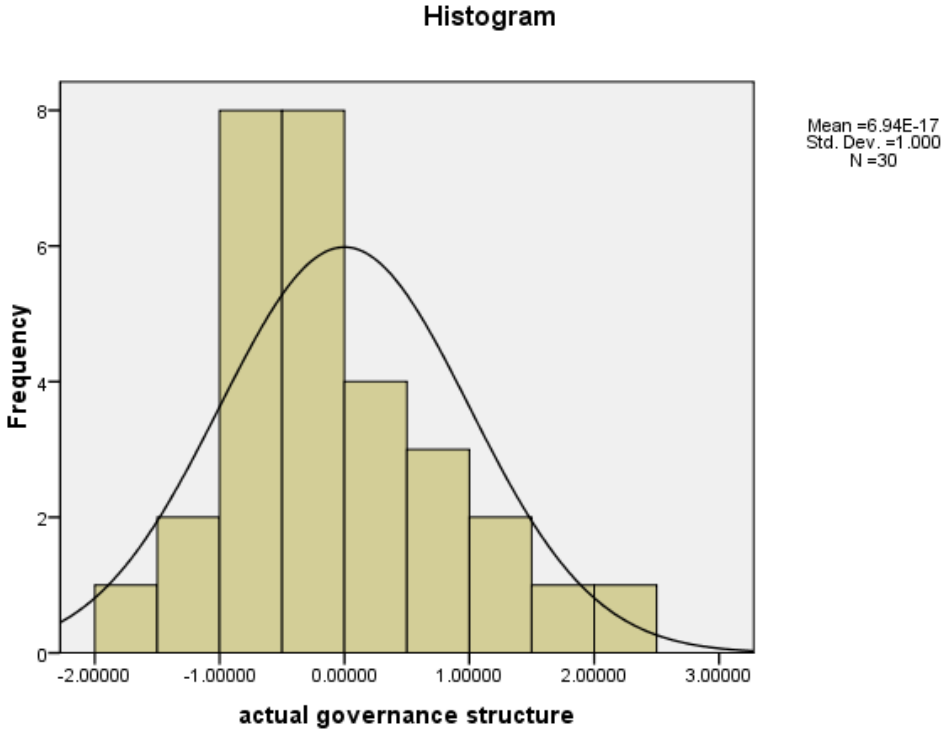

Figure 7. *Bar chart dispersion actual governance structure*

This results in the classification of table 24, which is a copy of table 13.

Score governance analysis	Type of governance in place	Percentage of data in category
-1.704 – -0.502	Close to market governance	33,3%
-0.501 – 0.440	Pure (hybrid) governance	36,7%
0.441 – 2.400	Close to hierarchical governance	30%

Table 24. *Classification scores of 'governance structure'*

This classification of actual governance structure results in the bar chart depicted in figure 8. Of the 30 alliances, 10 are close to a market governance, 11 are a pure hybrid governance and nine are close to a hierarchical governance.

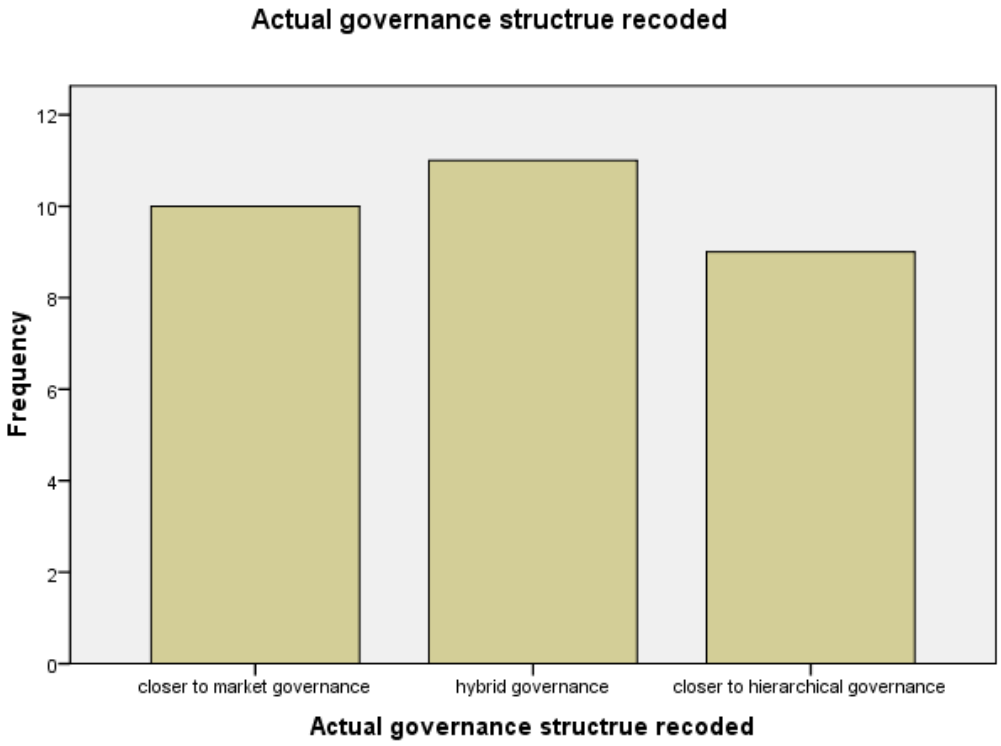

Figure 8. *Bar chart actual governance structure*

4.2. Type of R&D transaction

In the first contact with the company, it was asked whether they had any R&D collaborations. The companies in the PV sector which did have R&D transactions were send a questionnaire. In the returned questionnaires the R&D collaborations are classified in by type of collaborations. The main part, about 43% of the R&D collaborations are knowledge transactions, 40% are innovation transactions, about 13% were knowledge as well as innovation transaction and a small 3% were knowledge and financial transactions. This is graphically represented in figure 9.

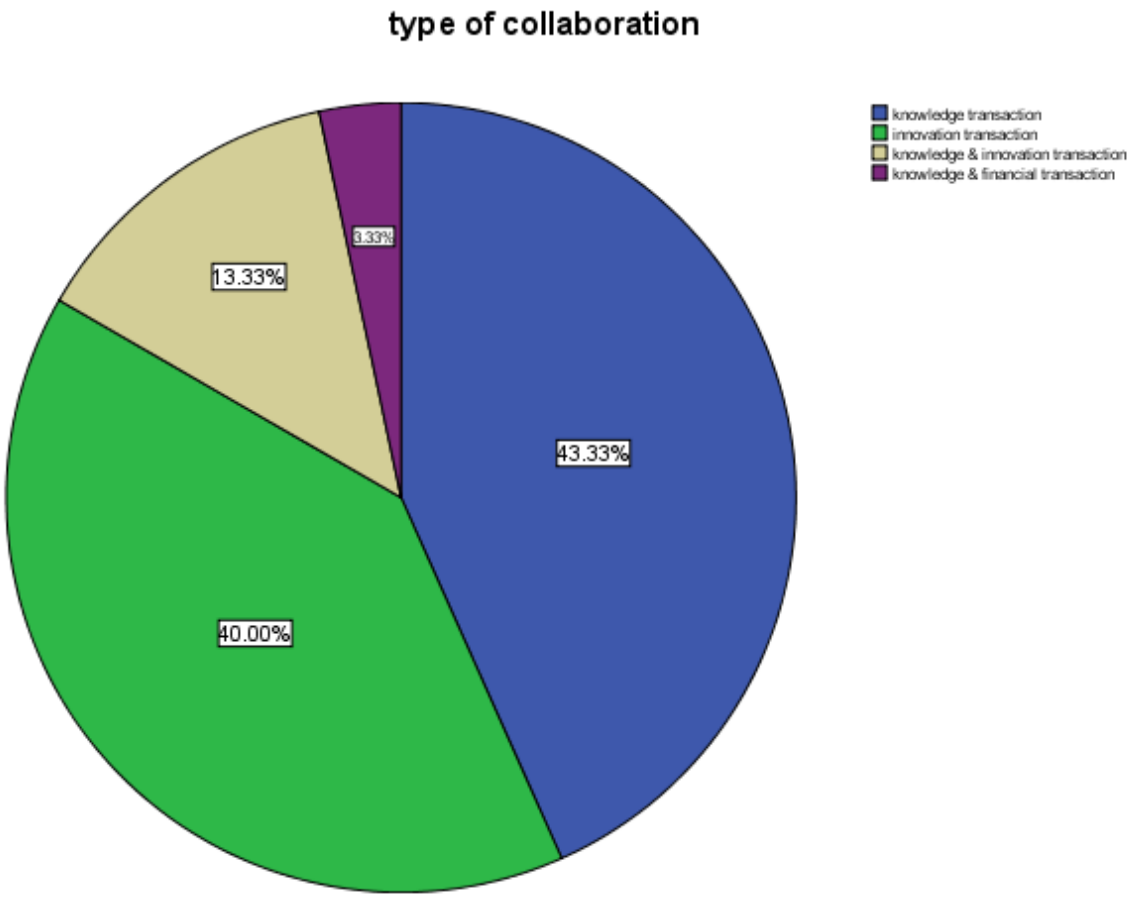

Figure 9. *Type of R&D transaction*

4.3 Misalignment

Of the found alliances, 63,3% is misaligned, and the resulting minority of 36,7% is aligned. Stated differently, about one third of the transactions are aligned, which is graphically shown in figure 10.

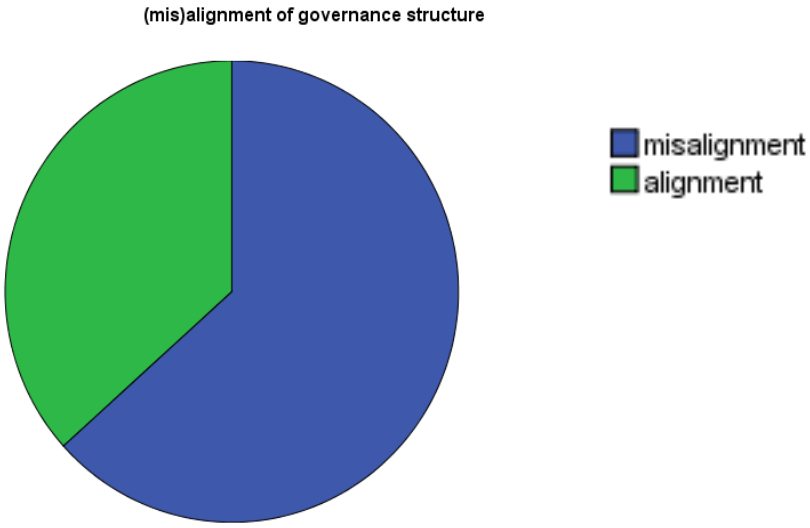

Figure 10. *(mis)Alignment of governance structure*

Misalignment can take two forms; risk of opportunism, or excessive bureaucracy, as has been extensively explained in the methods section. The resulting types of misalignment are shown in figure 11. Main conclusion about this figure is that a misalignment of type 2, risk of opportunism, is present in about 75% of the collaborations that are misaligned.

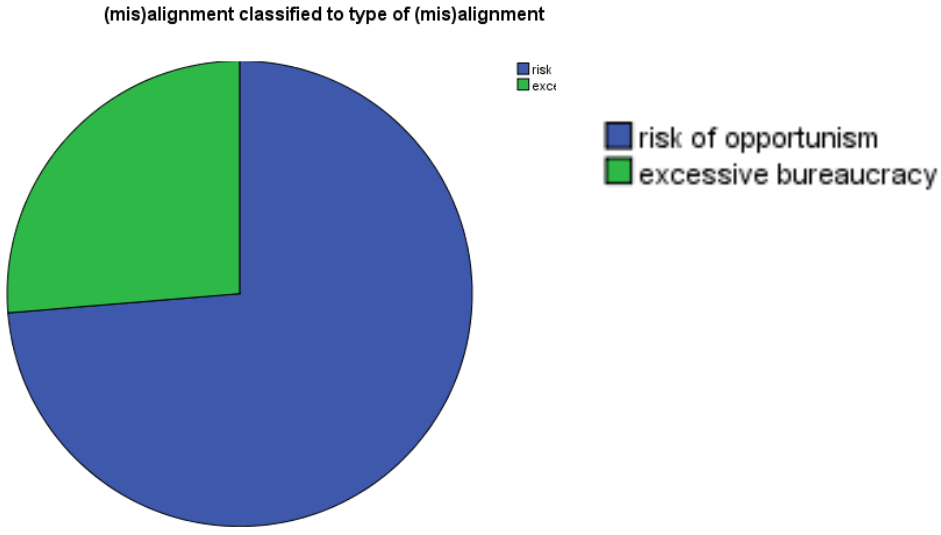

Figure 11. *Results: types of (mis)alignment*

4.4 Innovative performance

The factor created indicating the innovative performance has a range of -1.37 to 2.24. The lower values indicate a poor performance, and the higher a good performance. The innovative performance has a distribution which comes close to a normal distribution (see figure 12).

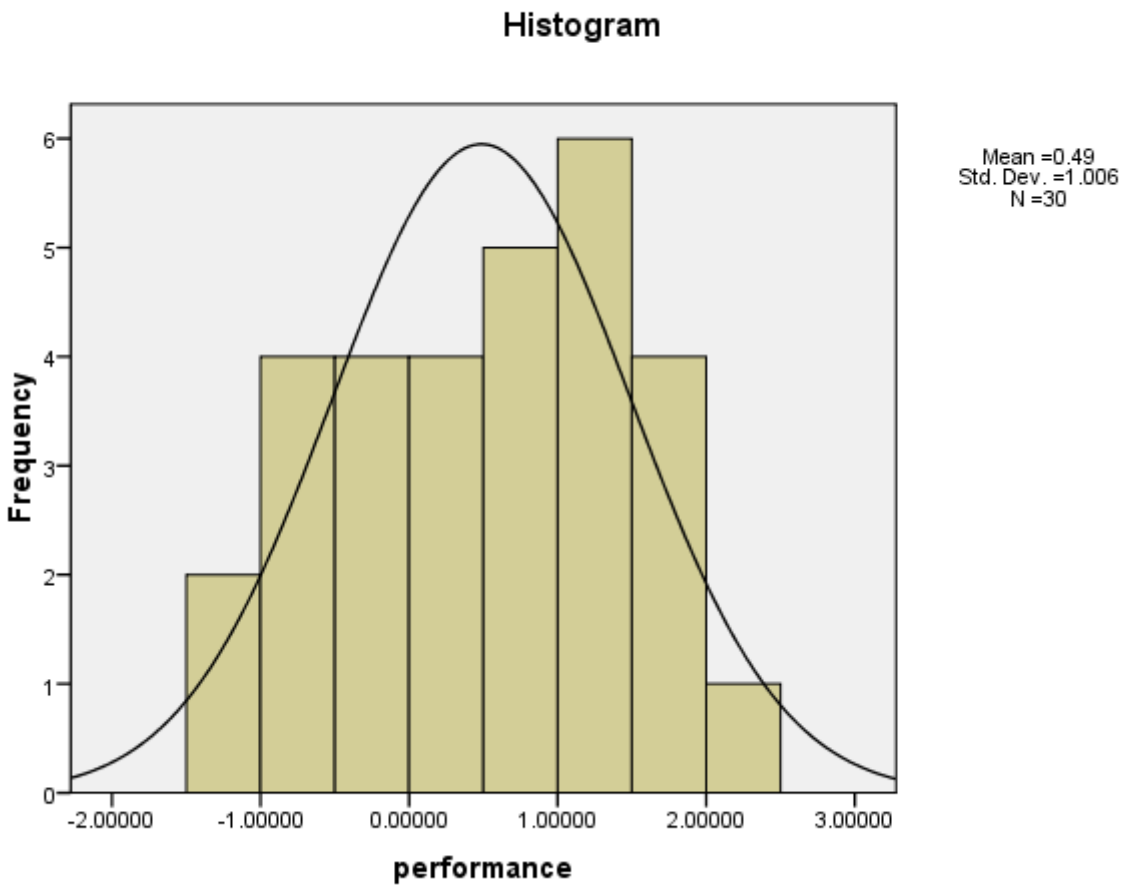

Figure 12. *Innovative performance distribution*

4.5 Correlation (mis)alignment & performance

With the use of a Kendall's tau correlation, the correlation coefficient is found, see table 25. The found correlation coefficient is significant at the 0,01 level, and has a value of 0,556. Stated differently in a formula: Performance = 0,556*Alignment + error
Transactions that are aligned have an overall better performance of 56%.

Correlations

			Performance	(mis)Alignment of governance structure
Kendall's tau_b	Performance	Correlation Coefficient	1.000	.556**
		Sig. (1-tailed)	.	.000
		N	30	30
	(mis)Alignment of governance structure	Correlation Coefficient	.556**	1.000
		Sig. (1-tailed)	.000	.
		N	30	30

**. Correlation is significant at the 0.01 level (1-tailed).

Table 25. *Correlation matrix of performance and misalignment*

In order to check which type of misalignment contributes most to the fact that misaligned transactions have a lower performance, again a Kendall's tau correlation regression has been performed. The results of this analysis can be found in table 26. Both the relation of 'risk of opportunism' and 'risk of bureaucracy' have a significant (at a 0.05 level) negative relationship with performance. The risk of opportunism has a correlation coefficient with performance of -0.335. Stated differently misaligned alliances with the risk of opportunism have overall 33,5% less performance. The risk of excessive bureaucracy has a correlation coefficient of -0,270 with performance. Stated differently misaligned alliances with the risk of bureaucracy have overall 27% less performance.

Correlations

			performance	dummy_ opportunism	dummy_ bureaucracy
Kendall's tau_b	performance	Correlation Coefficient	1.000	-.335*	-.270*
		Sig. (1-tailed)	.	.016	.042
		N	30	30	30
	dummy_opportunism	Correlation Coefficient	-.335*	1.000	-.418*
		Sig. (1-tailed)	.016	.	.012
		N	30	30	30
	dummy_bureaucracy	Correlation Coefficient	-.270*	-.418*	1.000
		Sig. (1-tailed)	.042	.012	.
		N	30	30	30

*. Correlation is significant at the 0.05 level (1-tailed).

Table 26. *Correlation matrix of performance and 'risk of opportunism' and 'risk of excessive bureaucracy'*

5. Discussion

This chapter first will give an extensive analysis of the results presented in the previous section. This brings us to the managerial implications. The second paragraph presents the limitations of the research, and some future research recommendations are given which could add value to this research.

5.1 Analysis results

The total sample was constructed out of 30 alliances, from which 8 are theoretically best governed in a governance structure closer to the market, 4 are best governed in a pure hybrid governance structure and the other 18 alliances are best governed in a governance structure closer to hierarchical governance. This image is consistent with the characteristics of R&D collaboration: as these alliances are highly knowledge intensive, commitment is required and the expenses of setting up such an alliance bring along high asset specificity and uncertainty.

However, the actual governance structure does not have a distribution consistent with a typical R&D alliance governance structure. Of all 30 alliances, 10 are governed in a governance structure close to market governance, 11 are pure hybrids, and the 9 remaining are governed in a governance structure close to a hierarchy. Due to the difference in theoretical best governance structures and actual governance structures, a substantial part of the transactions is misaligned. In total 63,3% of the transactions is misaligned and the resulting minority of 36,7% is aligned. Two types of misalignment are identified: the hazard of excessive bureaucracy and the hazard of opportunism. Of the misaligned transactions, about 75% suffers from risk of opportunism, and the remaining 25% suffers excessive bureaucracy. Since the majority of the transactions is theoretically best governed in a governance structure close to a hierarchy, and since this was not the case with the actual governance structure, this dispersion of (mis)alignment was to be expected from the results.

The main tenet of this research is to link the misalignment of governance structures to the innovative performance of the alliance. The coefficient explaining this relationship is positive and significant, suggesting a relationship. Since *misalignment* captures with a 0 the misaligned transactions, and with a 1 aligned transactions, a positive coefficient indicates that as the alignment of the transactions in the sample increases, the overall innovative performance of the alliance becomes higher. As such, allying firms that are bound by a misaligned governance structure, have a lower innovative performance than allying firms that have implemented an aligned governance structure.

Since the hypotheses are about misalignment, the relationship between the two types of misalignment (i.e. ‘hazard of opportunism’ and ‘hazard of excessive bureaucracy’) and innovative performance is also assessed. Both types of misalignment have a significant negative correlation coefficient with innovative performance. In this case, the misaligned transactions are indicated with a 1, and the aligned transactions are indicated with a 0. A significant negative relationship coefficient indicates that when the transactions in the sample are misaligned, the overall innovative performance decreases. Opportunism has a negative coefficient of -0,335, meaning that alliances that suffer from the hazard of opportunism, have 33,5% less innovative performance than alliances that have aligned governance structures. And the risk of excessive bureaucracy has a coefficient of -0,270, meaning that alliances that suffer from the risk of excessive bureaucracy have 27% less innovative performance than alliances that have aligned

governance structures. The influence of risk of opportunism is somewhat bigger than the influence of risk of excessive bureaucracy.

The concluding results from propositions have direct managerial implications. First, this research suggests that a particular governance structure has to be chosen deliberately, taking into account the asset specificity and the uncertainty of the transactions. These factors (i.e. asset specificity and uncertainty) are not controllable by managers, and should therefore be controlled in the appropriate governance structure. Second, the research clearly indicates that when the governance structure is not aligned to the theoretical best governance structure, this has implications for the innovative performance. The role for the manger in the alliance, is to select the appropriate governance structure prior to the alliance. Transactions which have an aligned governance structure have an overall better innovative performance of 56%. Third, the research states that the risk of opportunism leads to even less innovative performance than the hazard of excessive bureaucracy, compared to aligned governance. Should a manager optimize governance structure along dimensions not considered in TCE (i.e. other criteria than opportunism hazards and excessive bureaucracy) then it is according to TCE advisable to choose a governance structure that brings excessive bureaucracy considering the innovative performance percentages. In other words, for a manager it is wise, when a misaligned governance structure is chosen, to choose one closer to a hierarchy, in order to avoid the risk of opportunism.

5.2 Limitations and future research

This research aimed to identify whether misalignment of governance results in less innovative performance. An interesting and decisive answer was given. However, the research also suffers from some limitations. The insights and limitations and critically reviewed by discussing the theory, method, data and results.

The theoretical framework of this research is based on the perspectives from 'transaction cost economics' (TCE), foremost developed by Williamson. TCE is an interdisciplinary approach to the study of organizations that joins economics, organization theory, and aspects of contract law. Transaction cost reasoning states that it has greater relevance for studying commercial than noncommercial companies, since the natural selection forces operate with greater assurance in the first one. My study focuses on both commercial as noncommercial (or public) firms. And, although from theory this is said to be not relevant, in my study the contrary is proven, and TCE shows itself to be relevant to both types of companies. Future research on this proposition should be done, to further empirically test the relevance of TCE in noncommercial firms.

The data used for this research is based on the operationalization of several studies by authors in the field of transaction cost economics, these are: David & han, 2004; Palay, 1984; Masten, 1984; Joskow, 1985;1987;1990; Olk & Young, 1997; Lunnan & Haugland, 2008; Anderson, 1985; Heide & John, 1990; Stump & Heide, 1996. However, the empirically testing of *(mis)alignment of governance structures* is largely underdeveloped. Therefore, operationalization is limited to the above research publications. Though, the theoretical framework used in this research has proven itself valuable. This research adds to the empirical testing of the concepts important in TCE. The fact that the hypothesis have both been confirmed, adds to the credibility of the chosen operationalization.

It has been difficult to select appropriate indicators for innovative performance, because this indicator is difficult to measure and quantify. Moreover, in most performance indicators

there is a time lag that prevents us to see the direct results. E.g. investments cannot be directly converted to profits; this takes time to sink in at the company and sometimes does not sink in at all, and then is in other words a useless investment. And, what is more, it is very difficult to draw a straight line from, for example, investments that are done in R&D to the gained profits in a specific year. Eventually the indicators of Davenport, de Long and Beers (1998) have been selected. Due to time and resource constraints only data on *current* alliances has been assembled. Had it been possible to gather data on the collaborations for several years, for example 2000-2010, then for example patents, with weighing of patent citation, would have been a good additional indicator. Patents with weighing of citations are an even less subjective indicator and are not as noisy as for example profits gained in a specific year.

Another methodological implication is the limited number of questionnaires that are used in this research. The sample was constructed of 30 questionnaires, which was a response rate of 58%. With the use of more questionnaires, it had been possible to further investigate the misalignment and have stronger conclusions. A recommendations to further research is to replicate this research in a different sector, which also has high R&D intensity and is knowledge based. This adds value when the research comes to the same conclusions and corroborates the conclusions found in the current research. Furthermore, additional research in the same sector can be done, using different indicators for 'asset specificity'. In my research two factors from 'human asset specificity' turned out to have an important impact on asset specificity (i.e. product- and process complexity). Additional research can give us insights in which types of asset specificity are important in misalignment of governance structure (e.g. human assets, physical assets or site specificity).

Care must be taken when generalizing the results, because firms might choose misaligned governance deliberately for multiple reasons. Collaboration partners may choose governance that optimizes along dimensions not considered in TCE, i.e. according to criteria other than opportunism hazards and excessive bureaucracy. Further analysis of how firms choose which governance structure is most appropriate would substantially improve this analysis.

To conclude, this study confirms the hypothesis of TCE, that governance selection ultimately affects the performance of the transaction. Other studies can use this study as a step to further research on the theme of misalignment of governance.

6. Conclusion

In this research I examine the effect of misaligned inter-firm governance on the success of a R&D collaboration. The overall research question is '*What is the effect of misalignment of an inter-firm governance structure on the success of a R&D collaboration on PV?'.*
Empirical results on a sample of 30 alliances in the Dutch PV industry provides support for the hypothesis that is prominent in the transaction cost literature: that governance selection ultimately affects the performance of the transaction. More specifically, misaligned governance dampens innovative performance, measured in growth of resources attached to the project. Results from the analysis above, confirm that transactions which have an aligned governance structure have an overall better innovative performance of 56%.

Two types of misalignment of governance structure are identified in the analysis: excessive opportunism hazards and excessive bureaucracy. In the theoretical section, based upon these types of misalignment, two main propositions are stated, to lead to answering the central research question. The first proposition states that the governance of R&D collaborations on PV, which are characterized by the risk of opportunism, decreases the chance of success of the collaboration.

This first proposition is applicable when allying firms choose a less hierarchical governance mode for a collaboration with substantial threats of opportunism. Analyzing the data brings us to confirm the first proposition. The relationship between the innovative performance and the risk of opportunism is a significant negative one. The coefficient is
-0,335, in other words: R&D collaborations in the Dutch PV industry which suffer from the risk of opportunism have 33,5% more chance to be *unsuccessful* than collaborations in which the governance is aligned.

The second proposition states that the governance of R&D collaboration on PV, which are characterized by the hazard of excessive bureaucracy, decreases the chance of success of the collaboration. This proposition is applicable when bureaucracy might dampen incentives to pursue more innovative ideas, and slow down decision making. Or in other words, when a more hierarchical governance mode for collaboration is chosen without the presence of substantial threats for opportunism and uncertainty. In either case of misalignment, innovative performance is reduced. This second proposition can also be confirmed. Again, the relationship between the innovative performance and hazard of excessive bureaucracy is a significant negative one. The coefficient is somewhat smaller than the one for risk of opportunism, but still, this can be seen as a substantial influence. With a coefficient of -0,270 it can be concluded that: R&D collaborations in the Dutch PV industry which suffer from the hazard of excessive bureaucracy have 27% more chance to be *unsuccessful* than collaborations in which the governance is aligned.

Conclusively, these insights illustrate that the misalignment in either case, hazard of excessive bureaucracy or risk of opportunism, dampens innovative performance in R&D collaborations in the Dutch PV industry. Furthermore, it can be concluded that in the case of misalignment, the risk of opportunism leads to 33,5% lower innovative performance, and the hazard of excessive bureaucracy leads to 27% lower innovative performance. In other words, when a company collaborates with a partner in a misaligned governance structure, it is even more harmful for the innovative performance to have the risk of opportunism, then to have the hazard of excessive bureaucracy.

A contribution to literature is done in the field of the use of TCE in alliances with non-commercial firms. As Kale and Singh (2009: 56) indicate, existing literature on successful alliance management has focused mainly on alliances between two or more commercial or for-profit firms. In practice, many firms are participating in a new type of alliance: those with non-commercial companies, and/or nongovernmental organizations. Underlying reason for this upcoming importance of this type of collaboration is that society views firms as entities that are not only responsible for the interest of their own stakeholders, but also to the interests of other stakeholders within the community. My research indicates that the use of TCE in both types of firms (i.e. commercial or for profit, and non-commercial) is very plausible, and relevant for these types of collaborations, in contrast to what existing TCE literature claims.

As a conclusive answer to the research question '*What is the effect of misalignment of an inter-firm governance structure on the success of a R&D collaboration on PV?*' we can conclude that misalignment of an inter-firm governance structure has a negative effect on the success of R&D collaboration in the PV industry. It does pay to have an aligned governance structure in a R&D collaboration, alliances that have an aligned governance structure have a significant overall better performance of 56%.

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Appendix A Collaboration sample

	Company name	Collaboration partner(s)	Type of company
1	TU Eindhoven	Helianthos	University
2	Nijmegen University	Anonym partner	University
3	University Amsterdam	ECN	University
4	Holst Centre	ECN, TU/e, TNO	R&D company
5	Dutch Polimer Institute	Anonym partner	TTI
6	Joint solar program (FOM)	Shell, Nuon	R&D company
7	Shell Research	JSP (FOM)	R&D company
8 **9** **10**	OTB Solar	Holst IAC TU/e	Equipment/material manufacturer
11	Meco	ECN	Equipment/material manufacturer
12 **13**	Avantor	ECN Anonymous industrial partner	Equipment/material manufacturer
14	Smit ovens	Solliance	Equipment/material manufacturer
15	Solland Solar	TU Delft	Cell/module producer
16	Helianthos	Ecopal	wholesale
17	Scheuten Solar	TNO	PV system producer
18	Levitech	ECN, Solland, Sunergy	Cell producer
19	Solar modules NL	Smart Chain	Wholesale
20 **21** **22** **23**	Ubbink Solar	KKB Kollektor HU Denta Anonym industrial partner	Cell producer
24	Van der Valk systems	TNO & ECN	System producer
25 **26**	Oskomera Solar power solutions	VDL Voestalpine	System producer
27	Eurotron	ECN, SunChemicals, Bakaert	System producer
28 **29**	Philips Innovation services	CIGSelf consortium Anonym cell producer	Cell producer
30	Tempress	ECN, TUDelft, Mallinckrodt Baker	Equipment/material manufacturer

Appendix B Questionnaire

Universiteit Utrecht

The questionnaire you will find below concerns your collaboration partner(s) in the field of R&D on photovoltaics (PV). In case you have several collaborations on PV, I would like to ask you to fill in *one questionnaire for each of your collaborations.* If you have for example two R&D projects, I would like to receive one questionnaire per collaboration. You can indicate your choice of answer **by making it bold.** Thank you very much in advance for your time!

Amanda Kaleveld, BSc

Your function within company:
Name/Names collaboration partner(s):
Type of collaboration (eg contract, joint venture, etc.) :

1.How would you define the collaboration with your partner(s), as a:

1. Knowledge transaction
2. Innovation transaction
3. Financial transaction
4. Other, namely…

2. Did you have to train your personnel specifically for this collaboration?

1. No, no education needed
2. Yes, relatively little education needed
3. Yes, education needed
4. Yes, much education was needed
5. Yes, very much education was needed

3. Did you make specific investments for this collaboration?

1. no
2. yes

When the answer on question three was no, please continue with question five.

4. Is information between you and your partners confidential due to the specific investments of question three?

1. no, information is not confidential
2. yes, information is confidential

5. How complex is the product that is designed within this collaboration?
    1. not complex at all
    2. relatively complex
    3. medium complex
    4. complex
    5. very complex
    6. not applicable

6. How complex is the process that is designed within this collaboration?
    1. not complex at all
    2. relatively complex
    3. medium complex
    4. complex
    5. very complex
    6. not applicable

7. Are investments done in a factory/plant specifically for this collaboration?
    1. no investments
    2. small investments
    3. medium investments
    4. large investments
    5. very large investments
    6. not applicable

8. Are investments done in equipment specifically for this collaboration?
    1. no investments
    2. small investments
    3. medium investments
    4. large investments
    5. very large investments
    6. not applicable

When the answers on question seven and eight were answered with 'no investments', please continue with question ten.

9. Please define in what the investments from question seven and eight have been done.

10. How would you describe the physical distance between you and your collaboration partner?
    1. very close (< 10 km)
    2. close by (10-40 km)
    3. not close, not far away (40-80)
    4. far away (80-120 km)
    5. very far away (> 120 km)

11. Do you have the same goals as your collaboration partner(s) concerning this collaboration?
    1. the goals are incongruent
    2. the goals are slightly incongruent
    3. the goals are relatively congruent
    4. the goals are congruent
    5. the goals are totally congruent

12. Which goal(s) from your point of view are applicable to this collaboration?
    1. Knowledge development
    2. Knowledge sharing
    3. Funding
    4. innovation
    5. other, namely…

13. Are indicators for success agreed upon beforehand, in order to assess the collaboration?
    1. yes
    2. no

14. How many times have you collaborated with this partner(s) before?
… time(s)

15. What is the duration of the contract with your collaboration partner(s)?
… year

16. Do you have the flexibility to adjust the contract while it still runs?
    1. no, the contract is very inflexible
    2. no, the contract is relatively inflexible
    3. the contract is not inflexible, nor flexible
    4. yes, the contract is relatively flexible
    5. yes, the contract is very flexible

17. Have the financial investments in the collaboration grown, compared to the start of the collaboration?
    1. no
    2. yes, small growth
    3. yes, not small, neither much growth
    4. yes, much growth
    5. yes, very much growth

18. Has the number of employees involved in the collaboration grown, compared to the start of the collaboration?
    1. no
    2. yes, small growth
    3. yes, not small, neither much growth
    4. yes, much growth
    5. yes, very much growth

19. Has the percentage of your R&D budget you spent on the collaboration grown, compared to the start of the collaboration?

1. no
2. yes, small growth
3. yes, not small, neither much growth
4. yes, much growth
5. yes, very much growth

20. Would you describe the project as a successful one? Please elaborate on your answer.

This is the end of the questionnaire. Thank you very much for filling in my questions.

Would you like to be updated on the results of the research? yes/no

Appendix C Operationalization of Questionnaire

Question number	Attribute of TCE	Measure	Indicator	Value	Meaning
1 (open question)					
2	Asset specificity	Human assets	Training	1 = no need at all 2 = relatively little need 3 = yes, education needed 4 = yes much education needed 5 = yes very much education needed	1 = low asset specificity 5 = high asset specificity
3			Confidentiality of information	1 = no 2 = yes	1 = low asset specificity 2 = high asset specificity
4			Confidentiality of information	1 = no 2 = yes	1 = low asset specificity 2 = high asset specificity
5			Complexity of product	1 = not complex 2 = relatively complex 3 = medium complex 4 = complex 5 = very complex 6 = not applicable	1 = low asset specificity 5 = low asset specificity 6 = NA
6			Complexity of process	1 = not complex 2 = relatively complex 3 = medium complex 4 = complex 5 = very complex 6 = not applicable	1 = low asset specificity 5 = low asset specificity 6 = NA
7		Physical assets	Sunk costs in plant (Idiosyncratic investments)	1 = no investments done 2 = small investments done 3 = medium investments done 4 = large investments done 5 = very large investments done 6 = not applicable	1 = low asset specificity 5 = high asset specificity 6 = NA

8			Sunk costs in equipment(Idio syncratic investments)	1 = no investments done 2 = small investments done 3 = medium investments done 4 = large investments done 5 = very large investments done 6 = not applicable	1 = low asset specificity 5 = high asset specificity 6 = NA
9 (open question)					
10		Site	proximity	1 = very close by (< 10 km) 2 = close by (10-40 km) 3 = not close, not far away (40-80 km) 4 = far away (80-120 km) 4 = very large distance (> 120 km)	1 = high asset specificity 5 = low asset specificity
11	Uncertainty	Behavioral	Goal congruence between parties	1 = goals are incongruent 2 = goals are slightly incongruent 3 = goals are relatively congruent 4 = goals are congruent 5 = goals are totally congruent	1 = high uncertainty 5 = low uncertainty
12			Goal congruence between parties	1 = knowledge development 2 = knowledge sharing 3 = resources sharing 4 = innovation 5 = other; ….	Check between collaboration partners
13			Performance ambiguity	1 = yes 2 = no	1 = low uncertainty 2 = high uncertainty
15	Actual governance		Contracted durance	…. years	Low = closer to market governance

	structure				High = closer to hierarchic governance
			Contract flexibility	1 = no, very inflexible contract 2 = no, relatively inflexible contract 3 = contract is not inflexible, nor flexible 4 = yes, relatively flexible contract 5 = yes very flexible contract	1 = closer to hierarchic governance 5 = closer to market governance
17	Success of R&D collaboration	Growth in resources attached to project	Money	1 = no growth 2 = very small growth 3 = nor very small/nor very large growth 4 = large growth 5 = very large growth	1 = not successful 5 = very successful
18			People	1 = no growth 2 = very small growth 3 = nor very small/nor very large growth 4 = large growth 5 = very large growth	1 = not successful 5 = very successful
19			R&D budget	1 = no growth 2 = very small growth 3 = nor very small/nor very large growth 4 = large growth 5 = very large growth	1 = not successful 5 = very successful
20			Successful?	1 = yes 2 = no	Check with answers Q 17, 18, 19
14		Frequency of collaboration	Number of collaboration	… times	Find a main, and standard dev. Above main = high frequency Below main = low frequency

Appendix D SPSS Descriptive output

Asset specificity

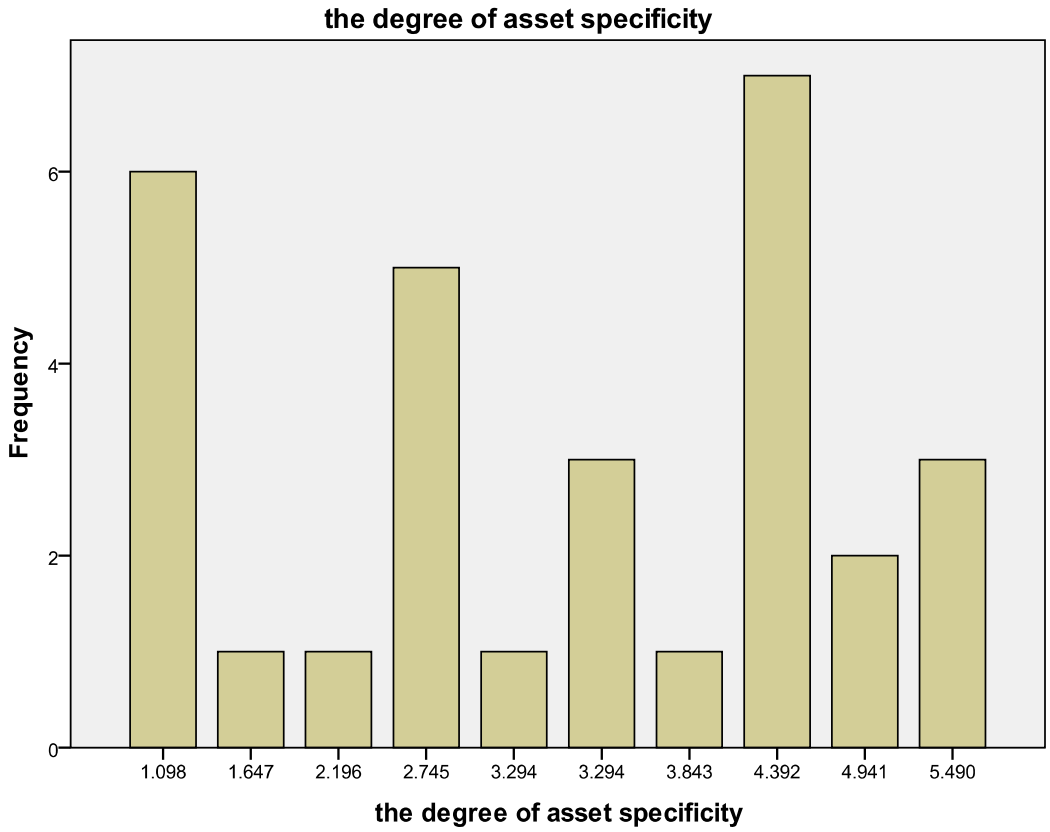
the degree of asset specificity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.098	6	20.0	20.0	20.0
	1.647	1	3.3	3.3	23.3
	2.196	1	3.3	3.3	26.7
	2.745	5	16.7	16.7	43.3
	3.294	1	3.3	3.3	46.7
	3.294	3	10.0	10.0	56.7
	3.843	1	3.3	3.3	60.0
	4.392	7	23.3	23.3	83.3
	4.941	2	6.7	6.7	90.0
	5.490	3	10.0	10.0	100.0
	Total	30	100.0	100.0	

Statistics

the degree of asset specificity

N	Valid	30
	Missing	0
Mean		3.27570
Std. Error of Mean		.269061
Median		3.29400
Mode		4.392
Std. Deviation		1.473709
Variance		2.172
Minimum		1.098
Maximum		5.490



Uncertainty

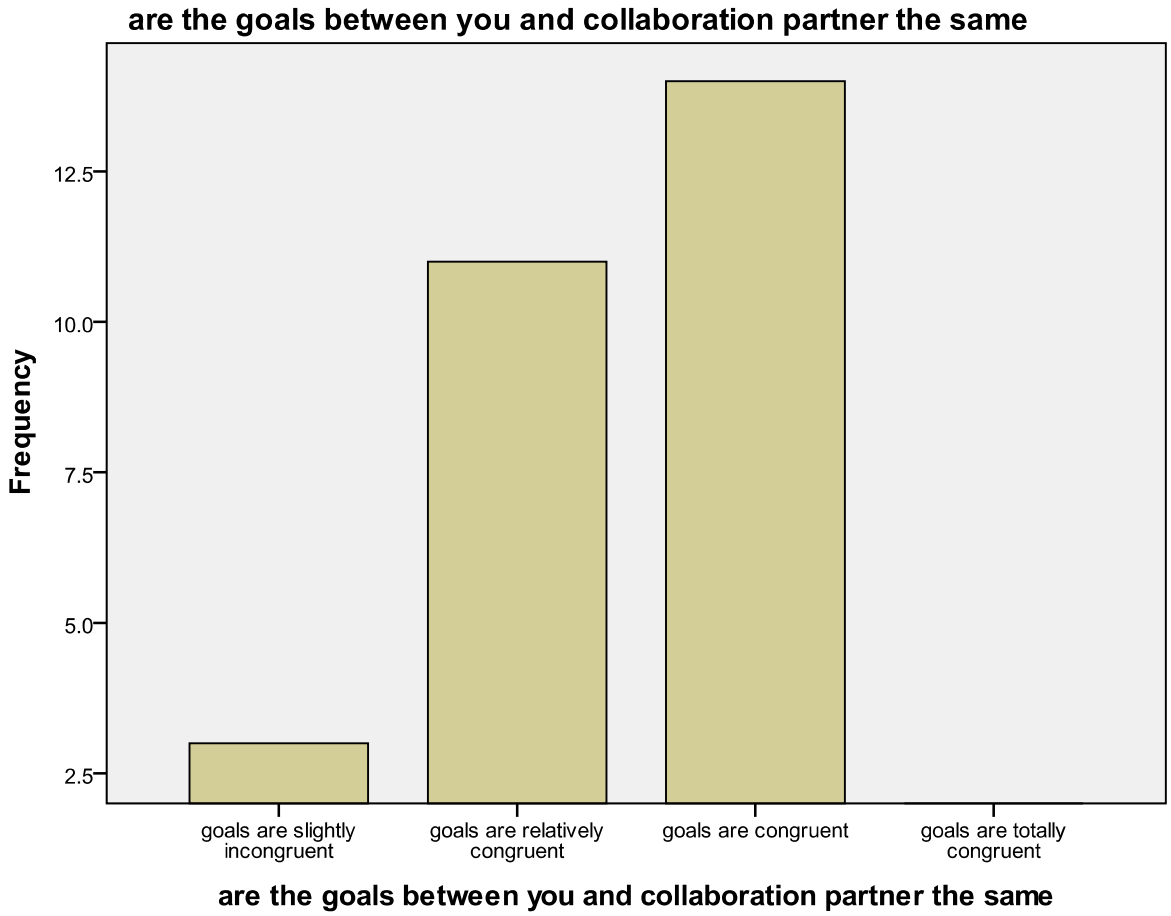
are the goals between you and collaboration partner the same

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	goals are slightly incongruent	3	10.0	10.0	10.0
	goals are relatively congruent	11	36.7	36.7	46.7
	goals are congruent	14	46.7	46.7	93.3
	goals are totally congruent	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Statistics

are the goals between you and collaboration partner the same

N	Valid	30
	Missing	0
Mean		3.50
Std. Error of Mean		.142
Median		4.00
Mode		4
Std. Deviation		.777
Variance		.603
Minimum		2
Maximum		5



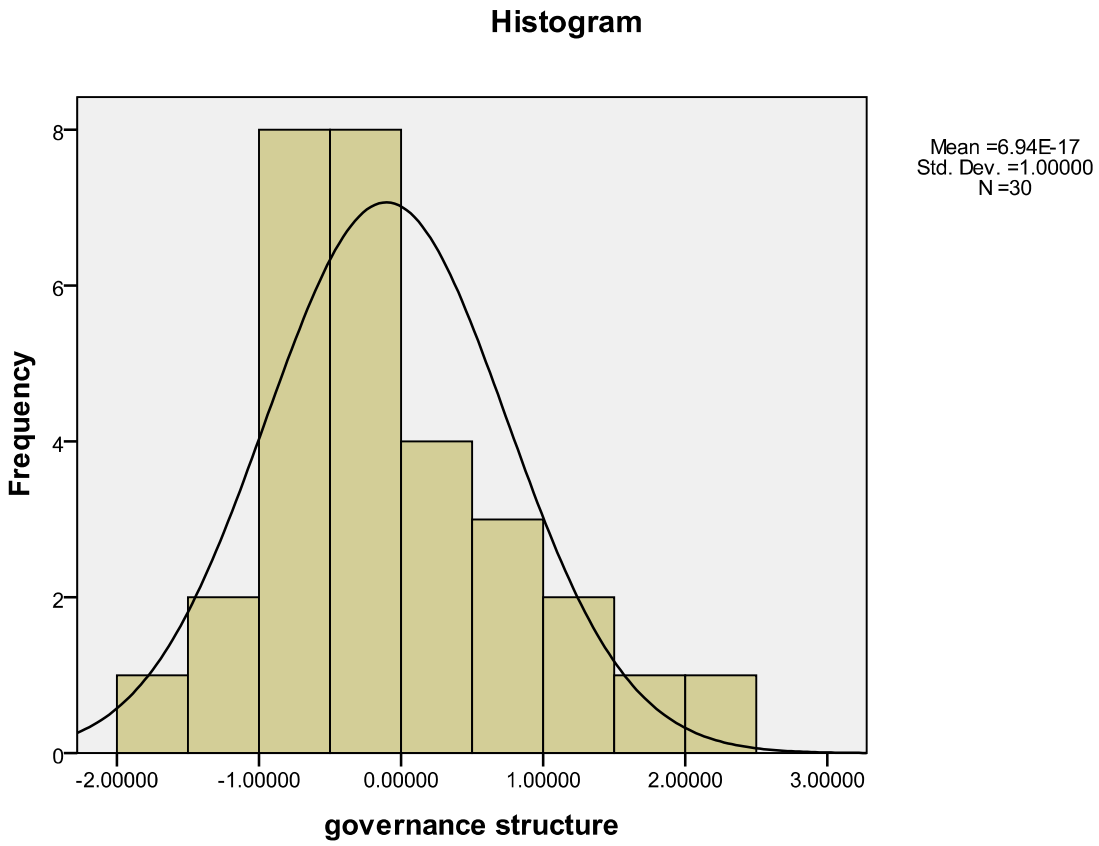
Governance structure

Statistics

governance structure

N	Valid	30
	Missing	0
	Mean	.0000000
	Median	-.0310067
	Mode	-.97299[a]
	Std. Deviation	1.00000000
	Variance	1.000
	Range	4.10010

a. Multiple modes exist. The smallest value is shown



governance structure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-1.7036444885668842	1	3.3	3.3	3.3
	-1.4681489278153084	1	3.3	3.3	6.7
	-1.2084844736418459	1	3.3	3.3	10.0
	-0.9971578063121568	2	6.7	6.7	16.7
	-0.97298891289027	3	10.0	10.0	26.7
	-0.7133244587168074	1	3.3	3.3	30.0
	-0.5019977913871183	2	6.7	6.7	36.7
	-0.24233333721365571	2	6.7	6.7	43.3
	-0.05517556330585345	1	3.3	3.3	46.7
	-0.03100666988396663	3	10.0	10.0	56.7
	-0.00683777646207986	2	6.7	6.7	63.3
	0.43998445161918504	2	6.7	6.7	70.0
	0.48832223846295864	2	6.7	6.7	76.7
	0.9109755731223368	1	3.3	3.3	80.0
	0.9593133599661103	2	6.7	6.7	86.7
	1.2189778141395728	1	3.3	3.3	90.0
	1.430304481469262	1	3.3	3.3	93.3
	1.9254644963943004	1	3.3	3.3	96.7
	2.3964556178974523	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

type of collaboration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	knowledge transaction	13	43.3	43.3	43.3
	innovation transaction	12	40.0	40.0	83.3
	knowledge & innovation transaction	4	13.3	13.3	96.7
	knowledge & financial transaction	1	3.3	3.3	100.0

type of collaboration

	Frequency	Percent	Valid Percent	Cumulative Percent
knowledge transaction	13	43.3	43.3	43.3
innovation transaction	12	40.0	40.0	83.3
knowledge & innovation transaction	4	13.3	13.3	96.7
knowledge & financial transaction	1	3.3	3.3	100.0
Total	30	100.0	100.0